25X1

PHOTOGRAPHIC INTERPRETATION REPORT

25X1C

LAPICHI-TYPE LINEAR ARRAYS AND VERTICAL RADIATORS USSR

25X1

JUNE 1969

COPY 130

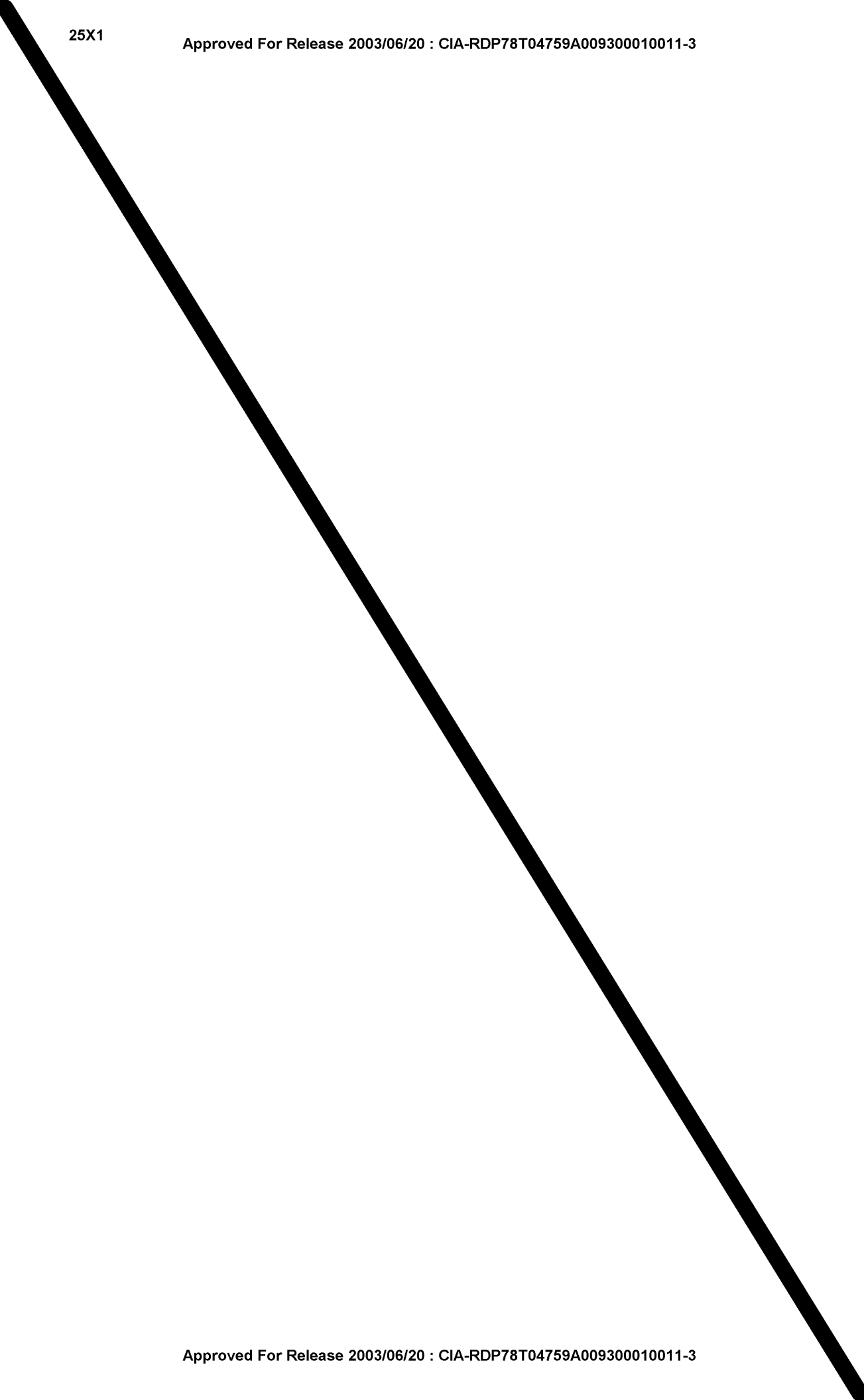
34 PAGES

25X1

Declass Review by NIMA/DOD

GROUP 1: EXCLUDED FROM AUTOMATIC DOWNGRADING AND DECLASSIFICATION

25X1C



INSTALLATION OR ACTIVITY NAME					COUNTRY
Lapichi-Type Linear Arrays and Vertical Radiators					UR
UTM COORDINATES	GEOGRAPHIC COORDINATES	CATEGORY	BE NUMBER	COMIREX NO.	NIETB NO.
NA	See Below	See Below	See Below	See Below	See Below

MAP REFERENCE

ACIC. US Air Target Charts 200, Scale 1:200,000

LATEST IMAGERY USED	NEGATION DATE (If required)
See Photographic References	See Below

REQUIREMENT	NEGATION DATE (If required)
CIA /OSI/C-SI6-84079, DIA/40-66, DIC/FTD/37-66	[redacted] 25X1D

ABSTRACT

This report contains an extensive analysis of all known Lapichi-type linear arrays and vertical radiators which are of high interest to several agencies. The DIA Scientific Advisory Committee is interested in high-frequency antennas that may be suitable for over-the-horizon detection and the [redacted] is interested 25X1A in the unusually strong broadcast signals emanating from certain areas of the USSR which may be connected to the Lapichi-type facilities. Although other functions, such as ionospheric propagation research, are possible, photographic analysis indicates that the Lapichi-type linear arrays are utilized for national and international broadcasting. The facilities discussed in the report are listed below:

- Angarsk HF Communications Facility, Southwest; 52-26-00N 103-41-30E; [redacted] 25X1A
25X1A [redacted] 25X1D
- Kamo HF Communications Facility; 40-24-20N 045-12-10E; [redacted] 25X1A
25X1A [redacted] 25X1D
- Komsomolsk HF Communications Facility, South; 50-38-15N 136-56-20E; [redacted] 25X1A
25X1A [redacted] 25X1D
- Tbilisskaya HF Communications Facility; 45-28-10N 040-05-20E; [redacted] 25X1A
25X1A [redacted] 25X1D
- Krasnoye HF Communications Facility; 49-54-00N 024-40-10E; [redacted] 25X1A
25X1A [redacted] Negation Date: None. 25X1A
- Krasnyy Bor HF Communications Facility Popovka; 59-39-30N 030-42-30E; [redacted] 25X1A
25X1A [redacted] Negation Date: None.
- Kurgan-Tyube HF Communications Facility; 37-32-50N 068-48-20E; [redacted]
25X1A [redacted] 25X1D
- Lapichi HF Communications Facility; 53-24-30N 028-31-20E; [redacted] 25X1A
25X1A [redacted] Negation Date: None. 25X1A
- Novosibirsk HF Communications Facility Oyash; 55-30-00N 083-44-00E; [redacted]
25X1A [redacted] 25X1D
- Razdolnoye HF Communications Facility; 43-32-08N 131-56-13E; [redacted] 25X1A
25X1A [redacted] Negation Date: None.

INTRODUCTION

In recent years, the United States and the USSR have placed great emphasis on studies and experiments dealing with the use of HF ionospheric propagation as a long range radar system not dependent on line-of sight transmissions. This type of system has been designated over-the horizon detection (OHD).

25X1D Early in [redacted] a signal with the necessary characteristics for OHD was intercepted, apparently emanating from the Soviet Union. 1/ Since that time, a number of HF antennas deployed in the Soviet Union have been investigated to determine the possibility of the propagation of an OHD signal, including the Lapichi-type linear arrays and vertical radiators.

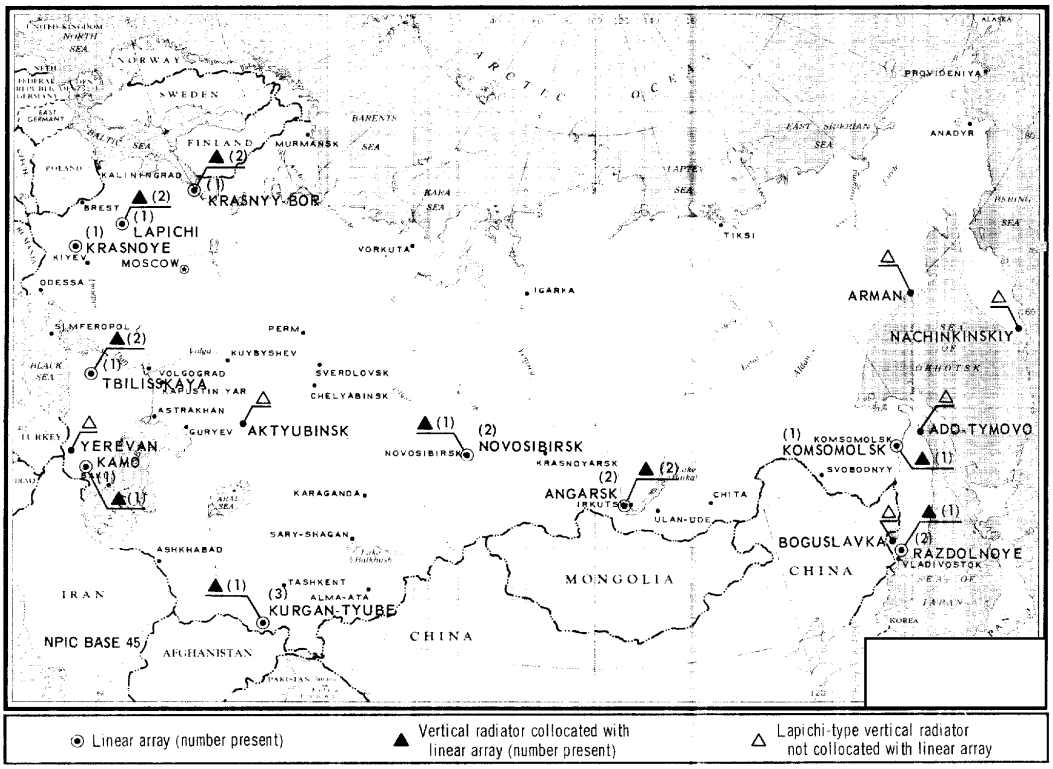
A total of 15 linear arrays have been seen at ten locations (Figure 1). Thirteen Lapichi-type vertical radiators have been found, with at least one at each linear array location except Krasnoye. As many as three linear arrays and as many as two vertical radiators have been found at one facility.

The preponderance of photo interpretation evidence supports the conclusion that these facilities are engaged in national and international radio broadcasting. The vertical radiators, with a probable range of more than one thousand miles, could broadcast far beyond the border areas of the USSR. The linear arrays could be effective beyond these ranges broadcasting at distances of several thousand miles or more. Evidence supporting this conclusion includes: the peripheral locations of the facilities; the broadcasting function of associated antennas; and the orientation of the antennas. Furthermore, there is no known association of medium frequency (MF) vertical-radiator signals with OHD signals; however, these antennas are collocated with the linear arrays and were built during the same time frame. There is no evidence at this time that will substantiate an OHD function for these facilities.

Although linear arrays were observed as early as [redacted] at Razdolnoye, it was not until 25X1D
25X1D [redacted] when a second antenna near Lapichi was observed, that linear arrays attracted interest. This was primarily due to the increased interpretability of photography of the antennas which permitted detailed analysis during construction. The Lapichi antenna had an unidentified function. Subsequently the array has been referred to as the "Lapichi linear array." During the same period, an associated vertical radiator was under construction at Lapichi which has been referred to as the "Lapichi vertical radiator." Subsequently identified antennas of this type have been designated as "Lapichi-type linear arrays" and "Lapichi-type vertical radiators." In this report, the two types of antennas will be called either typical linear arrays or linear arrays and either typical MF vertical radiators or MF vertical radiators.

The facilities are located around the periphery of the land mass of the Soviet Union (Figure 1), beginning in the Leningrad area, continuing around the western, southern, and southeastern portions of the Soviet Union, and terminating at the Komsomolsk Facility. It is obvious that these locations are ideal for international broadcasting.

This report consists of two parts. Part I deals with antenna design and is based primarily on ground photography. Part II deals with the individual facilities and concludes with Table 1, which summarizes details of the linear arrays and vertical radiators. Frequencies shown on Table 1 are based on an estimated radiating element wavelength and are approximate. The chronology presented in the text is abbreviated, presenting the major stages of construction of the linear arrays and vertical radiators.



25X1

FIGURE 1. LOCATIONS OF LINEAR ARRAYS AND VERTICAL RADIATORS.

BASIC DESCRIPTION

Part I--Antenna Design

Linear Arrays

General Description. Linear arrays incorporate a number of self-supporting, trussed towers (Figures 2 and 3) which are equal in height, equally spaced, and positioned in a straight line. The average height is [redacted] The 25X1D
25X1D average spacing is [redacted] however, the predominant
25X1D spacings are [redacted] all but one of the spacings fall within this range. The lengths of the arrays vary from [redacted] including their dissipation line 25X1D (Figure 4); however, the difference in length does not affect the basic components because the length is simply a function of the number of towers utilized in a given array.

Two separately suspended catenaries of conductors, which together make up the horizontal curtain, hang from a crossarm structure mounted on top of each pair of towers. However, at the center point between each pair of towers (one bay), there are two strain insulators, one for each set of conductors, with corona discharge rings at each end. This, in effect, divides the entire horizontal curtain catenary of conductors into two separate curtain elements, with the exception of the first and last bays of each linear array which have only one horizontal curtain element (the first and last towers have no adjoining curtain element but are simply used to support the catenary). This can be better visualized by realizing that each tower is the center feedpoint for a pair of curtain arrays, one on each side of the tower. Hence, there is no feedpoint on the first or last tower. From the feedtap point, near the top of each tower, there is a single downlead which may be a multiconductor. Figure 5 shows the relationship between the transmitting building, the feedlines, the dissipation lines, and the radiating elements.

Normally five feed support racks (Figure 6) are equally spaced at ground level between centers of each pair of towers. The downleads are rigged into these support racks which have four bays or sections carrying an undetermined number of conductors. These racks continue past the next-to-last tower and become a dissipation line (the conductor racks have been numbered on Figure 4 starting at the end of the array in a reverse manner). Normally the transmitting area is placed alongside the antenna toward the feed end. The feedlines travel directly to the first tower from the transmitting building. Examination of the control areas, which include cooling ponds, leaves little doubt that these linear arrays are transmitting antennas. Additionally, there is no need for dissipation lines on a receiving antenna.

Krasnoye Linear Array. Details of this array are derived almost exclusively from ground photography of good interpretability; however, this photography does not offer complete coverage of the antenna and does not include the transmitting area and transmission lines from the control building to the antenna.

This linear array incorporates 17 towers which are 135 feet high, and spaced 250 feet apart, and four feed-rack supports situated either between each pair of towers or within each bay (Figure 3). The tower spacing here is shorter than at the other linear arrays (Table 1). The basic design, however, remains the same.

Transmitting originates at the centrally located control building, which measures 230 by 45 feet. From here radio frequency (RF) transmission lines travel in several straight-
25X1D line segments which total about [redacted] before they enter the area of the first tower. At this point they proceed down the center line of the antenna, through each of the towers. The feed-support racks between the towers are detailed in Figure 6. As they pass through the towers, they are supported by the type of supports (Figure 6) which are mounted directly on each side of each tower. Both types have four conductor bays. Even though an accurate count of the number of conductors could not be made from available photography, indications are that a number exist.

Each tower, except the first and the last, has a downlead running from the feedracks up through the center of the tower, at which point it appears to feed a pair of horizontal curtains, one on each side of the tower top. In effect, this would then be a center-fed set of dipoles.

Within each bay and suspended from a pair of towers are two separate horizontal curtains insulated from each other by bar insulators [redacted] with corona discharge 25X1D
rings at their ends. This entire catenary has a vertical drop of [redacted] at the center. 25X1D

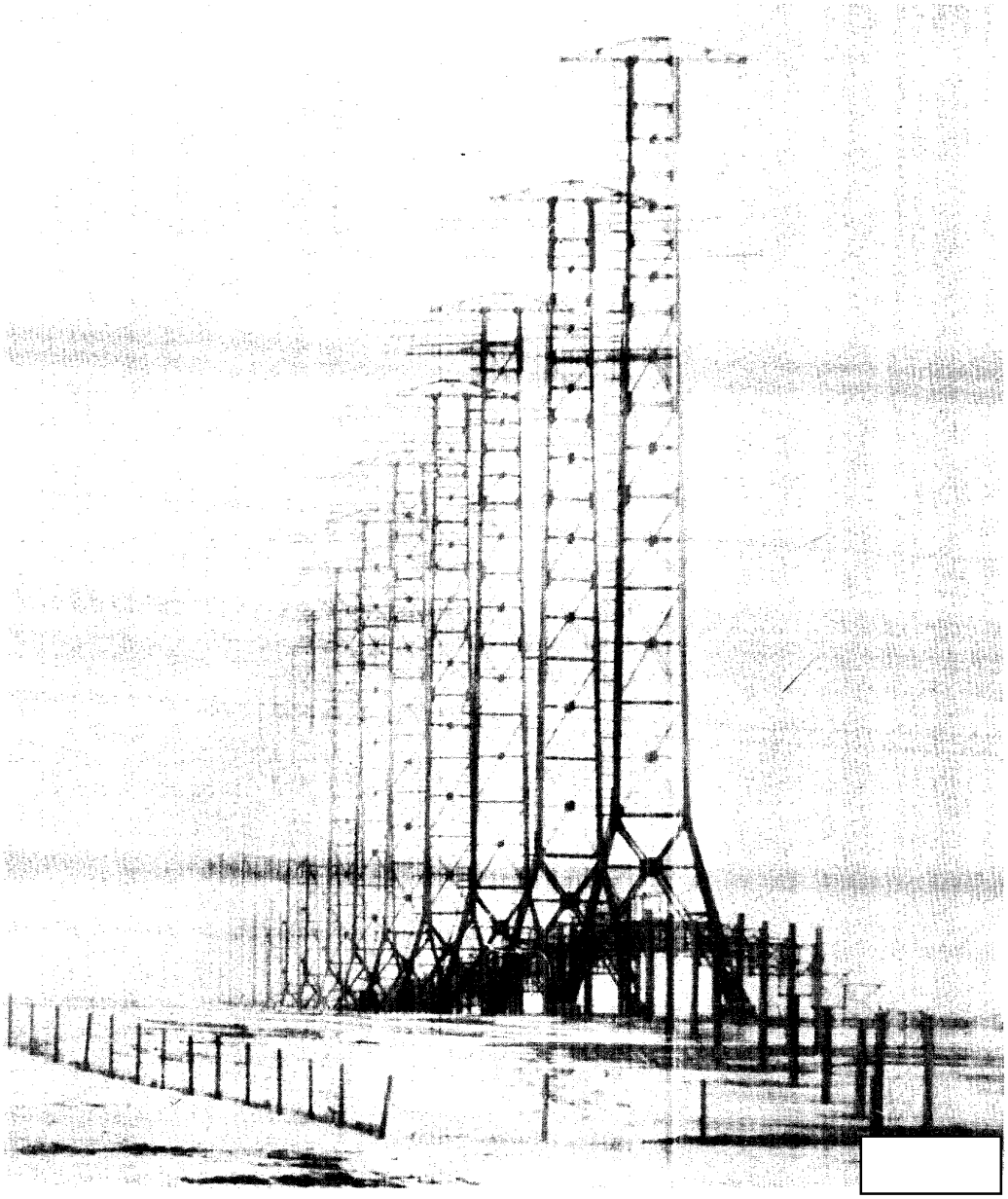
Each curtain is made up of two sections placed side by side, and each contains four parallel conductors. These conductors are held [redacted] apart by spreaders. At the ends of each section the conductors converge to a common point where the insulator is attached. It is observed that one type of feedrack is used between all towers. Beyond the last tower there are several types of conductor supports (Figures 3, 4, and 6; support racks are numbered in reverse order from the direction of RF current in Figure 4). The dissipation line begins at the sixteenth tower. 25X1D

It would appear that some of the conductors end before they reach the dissipation rigging terminus. Vertically placed tiebars have been used in some cases to terminate a conductor: this occurs on the first, the sixth, and the twelfth support racks.

Rigid Vertical Radiators

General Description. Vertical radiators have passed through many stages of development since their original deployment in the function of broadcasting. During the evolution of this type of antenna, there are three engineering advancements employed by the Soviet Union which stand out: 2/

The first is the utilization of top loading (capacitance loading). This feature has great economic value as it reduces the physical heights of the radiator with respect



25X1

FIGURE 2. GROUND PHOTOGRAPHY OF A LINEAR ARRAY (KRASNOYE HF COMMUNICATIONS FACILITY).

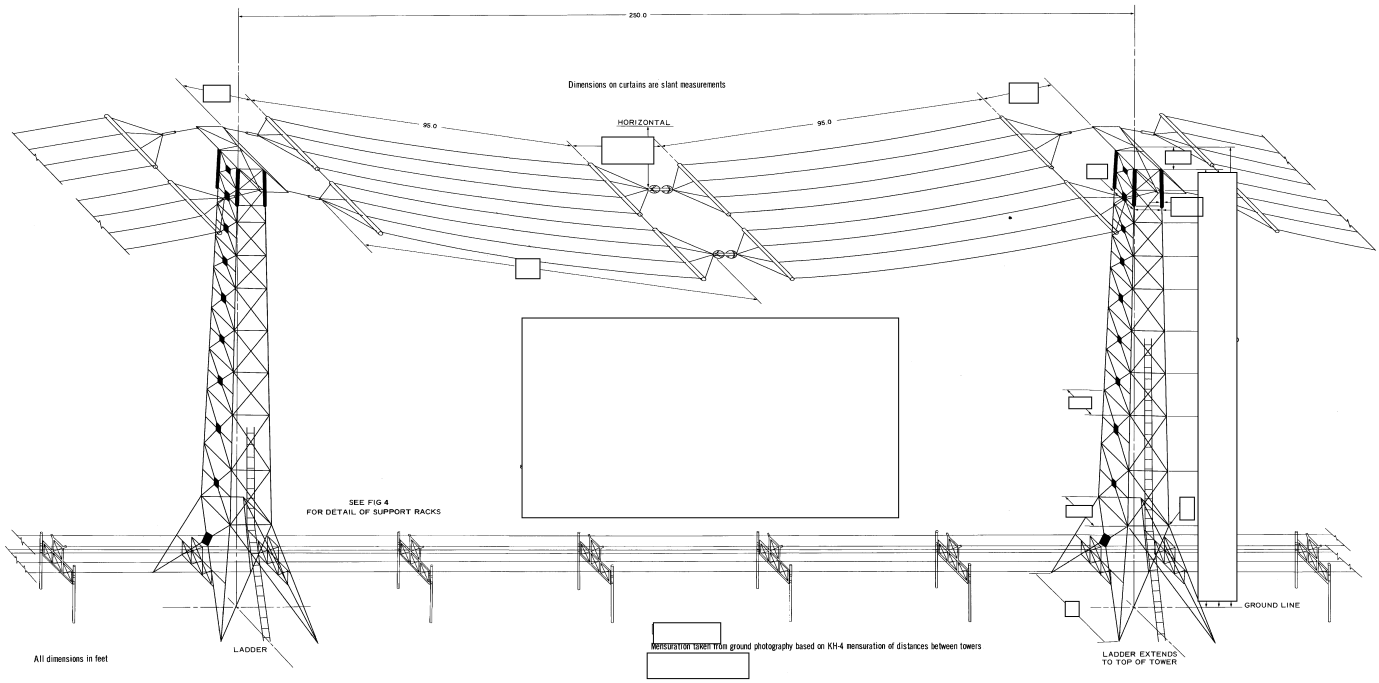


FIGURE 3. DETAILS OF A LINEAR ARRAY (KRASNOYE).

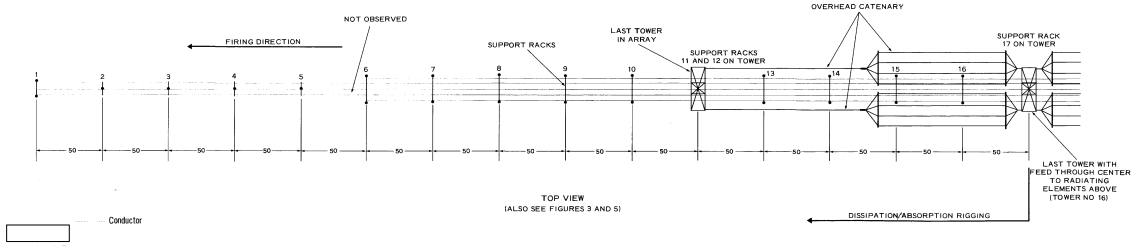
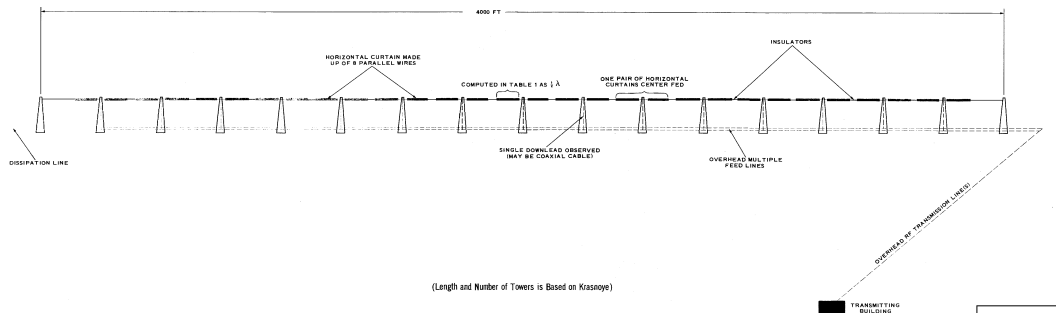


FIGURE 4. DETAILS OF LINEAR ARRAY DISSIPATION RIGGING.



(Length and Number of Towers is Based on Krasnoye)

FIGURE 5. BASIC ELECTRICAL CONSIDERATIONS OF A LINEAR ARRAY.

to the electrical height. That is, a shorter vibrator will appear longer electrically. Half-wavelength radiators have been proved to have good antifading properties. However, at broadcast frequencies, a half-wavelength radiator becomes extremely long; by reducing the length great savings can be realized, because vertical towers become more expensive per foot when they reach the higher elevations. Capacitance loading takes many forms, but this report concentrates primarily on the type utilizing inclined beams (Figure 7). These inclined beams (conductors) are suspended from the top of the tower and are held by insulated guy lines at the bottom.

The second Soviet improvement came about with the use of inclined conductors to reduce wave resistance. These conductors are suspended from the inclined beams just above the insulators and converge to a point on the lower portion of the tower (Figure 7).

The third and most significant advancement, which stems directly from G.Z. Ayzenberg's work 2/ is the use of the expanded wave cylindrical grid (Figure 7). This grid is comprised of from 6 to 12 vertical conductors positioned around the lower third of the radiator, but insulated from the radiator and connected to the ground system. A combination of the three developments produces, in essence, the Lapichi-type vertical radiator.

Lapichi-Type Vertical Radiator. Basically this is a rigid vibrator (trussed tower), insulated at the base from the ground and bottom fed (Figure 8). In most cases this antenna incorporates four stories of guying (Figures 9 and 10). The guying, spaced 120 degrees apart, supports towers which average [redacted] in height (Table 1). In addition 25X1D
to this guying, there are 12 outboard guys, 30 degrees apart, which support 12 inclined beams forming a capacitance cap (Figures 10 and 11). Twelve inclined conductors have been attached to the lower portion of the beams just above the insulators. These conductors converge to a point on the tower just above a cylindrical grid cage.

The grid is comprised of 12 conductors placed vertically about the towers every 30 degrees. Bar insulators are used to insulate these conductors from the tower and a dodecagonal support ring, from which they are suspended, a little more than one-third of the way up the tower. The bottom ends appear to be connected to a ring-like structure on the ground.

A ground radial system of wire which is tied into the system similarly to the one 25X1D
shown on Figure 8 originates at the base of the tower and extends out to the area of the cutboard anchors, in most cases. These radial wires are normally placed [redacted] apart, just below ground level. Overhead transmission lines originate at the transmitting building which is always placed outside the area of the ground system.

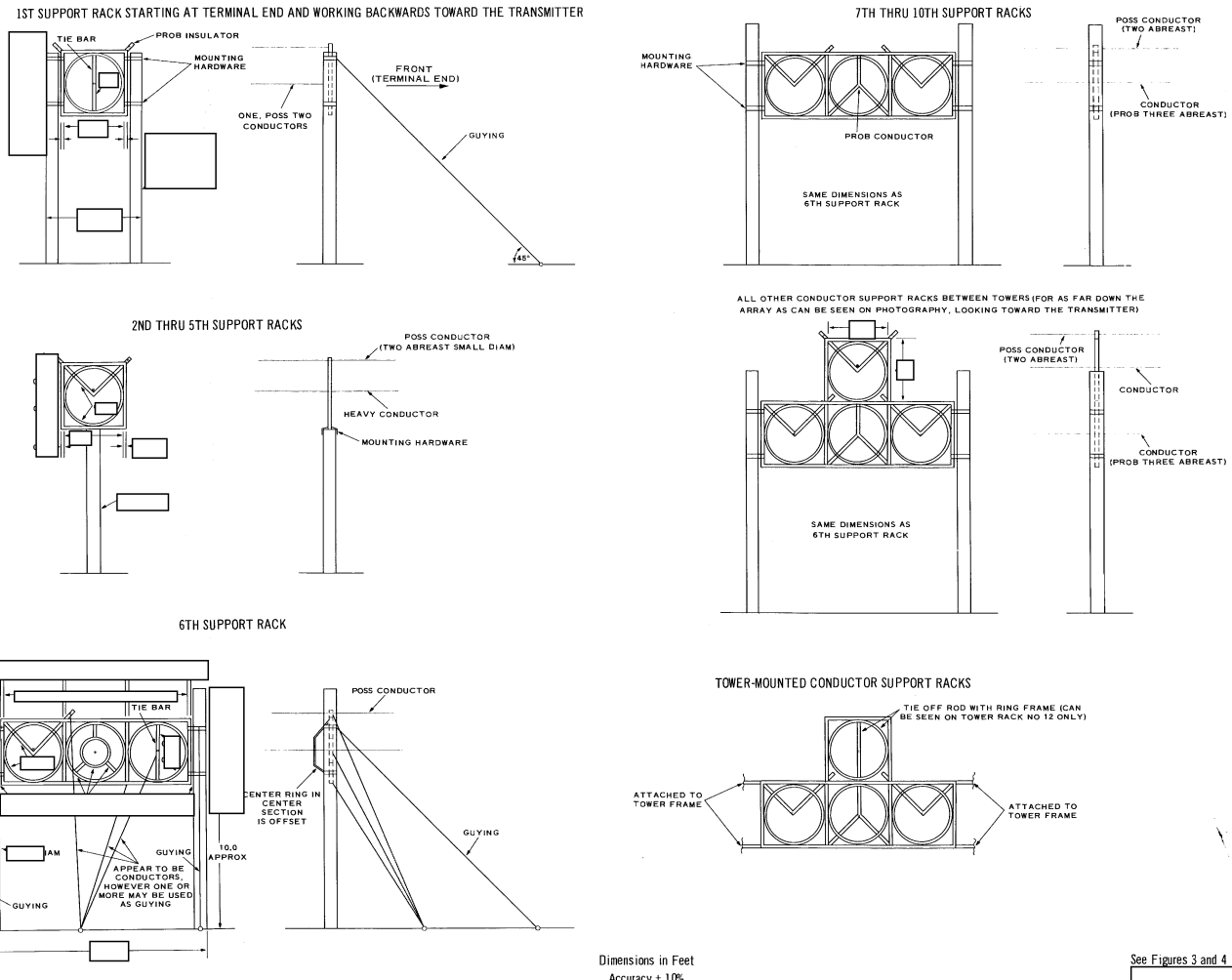
On Table 1, frequencies have been computed for each vertical radiator based on a one-half wavelength tower height. Also included on this table in parentheses are frequencies based on an estimated 20 percent reduction of height due to top loading.

Singularly deployed vertical arrays have an omnidirectional pattern. Four of the facilities included in Table 1 have two vertical radiators. Normally in these instances, the beam pattern would be somewhat broadside or directional, depending on the phase angle. However, if a directional beam is desired, the spacing of the elements would be a wavelength or less, and at these facilities spacing is as much as three wavelengths. This appears to negate their use as directive arrays. One other possibility exists--that of redundance; however, this is not normally necessary with this type of antenna.

The following is a list of the locations of other Lapichi-type vertical radiators which 25X1A
are not collocated with linear arrays:

- Arman Possible HF Communications Facility; 59-41-00N 150-09-40E; [redacted]
25X1A [redacted] Status: under construction.
- Boguslavka HF Communications Facility; 44-32N 131-39E; [redacted] BE None; No 25X1A
25X1A COMIREX; [redacted] Status: under construction. 25X1A
- Ado-Tymovo Probable HF Communications Facility; 51-05-30N 142-41-10E; [redacted]
25X1A BE None; No COMIREX; [redacted] Status: under construction.
- Nachikinskiy Possible MF Broadcast Station; 53-08-00N 157-41-50E; [redacted] BE None; 25X1A
25X1A No COMIREX; [redacted] Status: under construction.
- Yerevan Radio Station 3; 40-13-58N 044-33-13E; [redacted] No COMIREX; 25X1A
25X1A [redacted] Status: complete.
- Aktyubinsk Communications Facility Northwest; 50-17-10N 057-10-20E; [redacted]
25X1A [redacted] No COMIREX; [redacted] Status: complete.

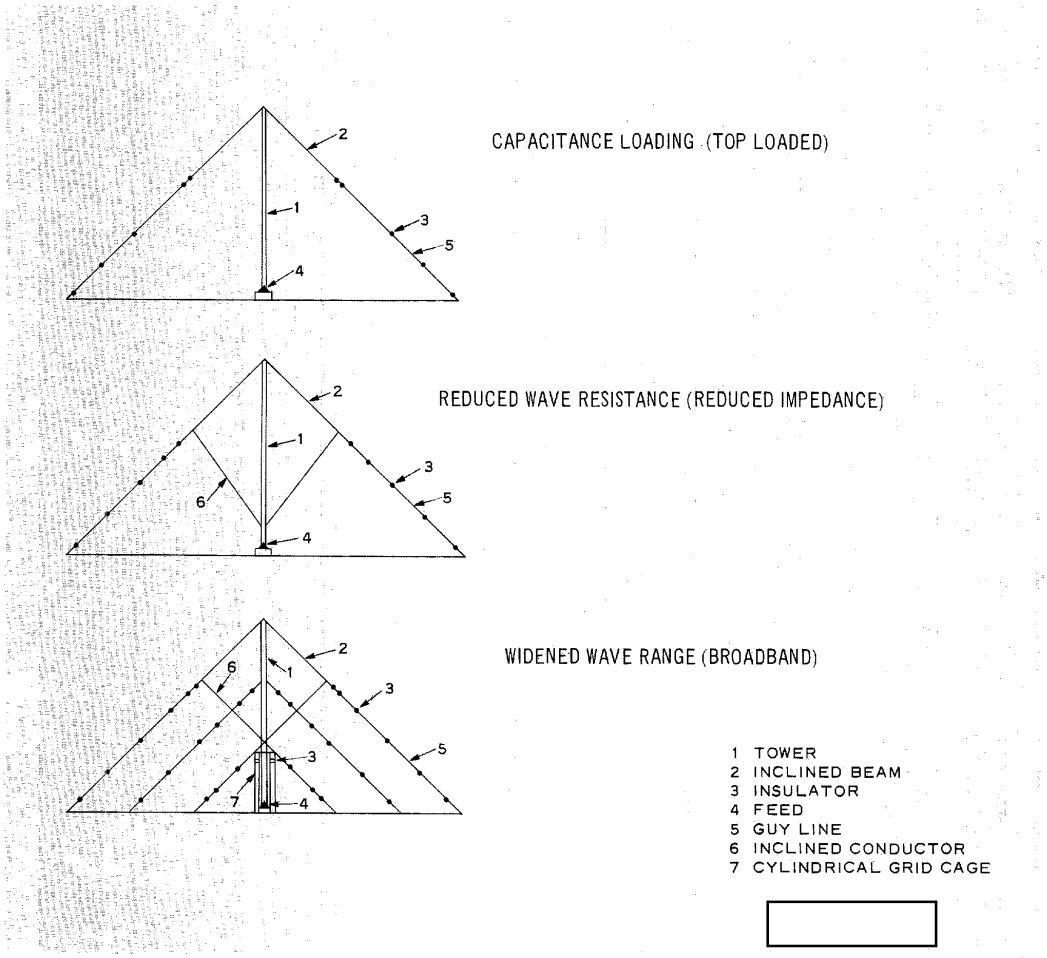
25X1A
25X1



Dimensions in Feet
Accuracy ± 10%

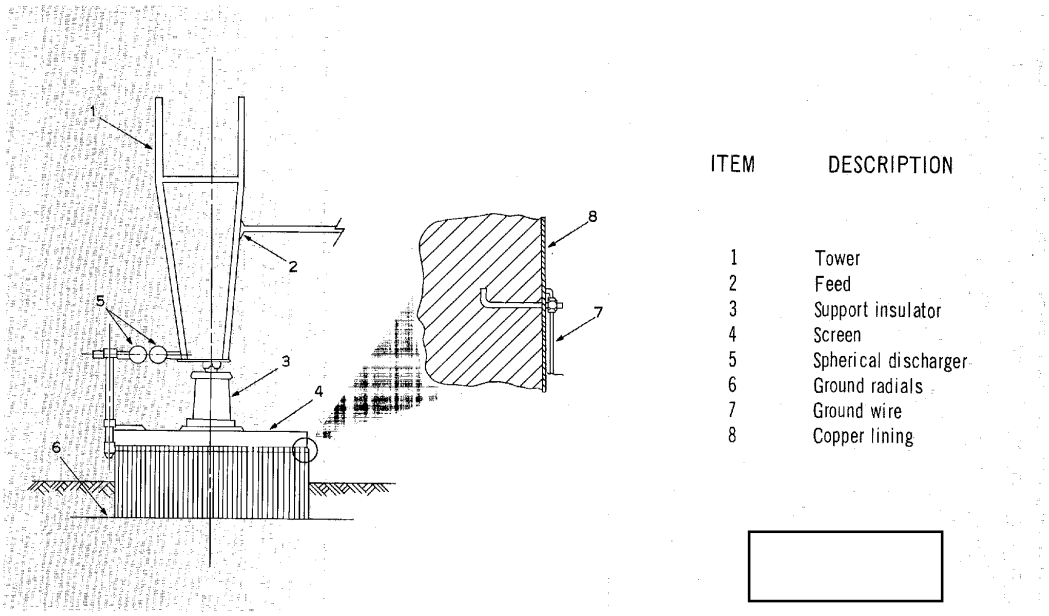
See Figures 3 and 4

FIGURE 6. DETAILS OF FEED/CONDUCTOR SUPPORT RACKS (KRASNOYE).



25X1

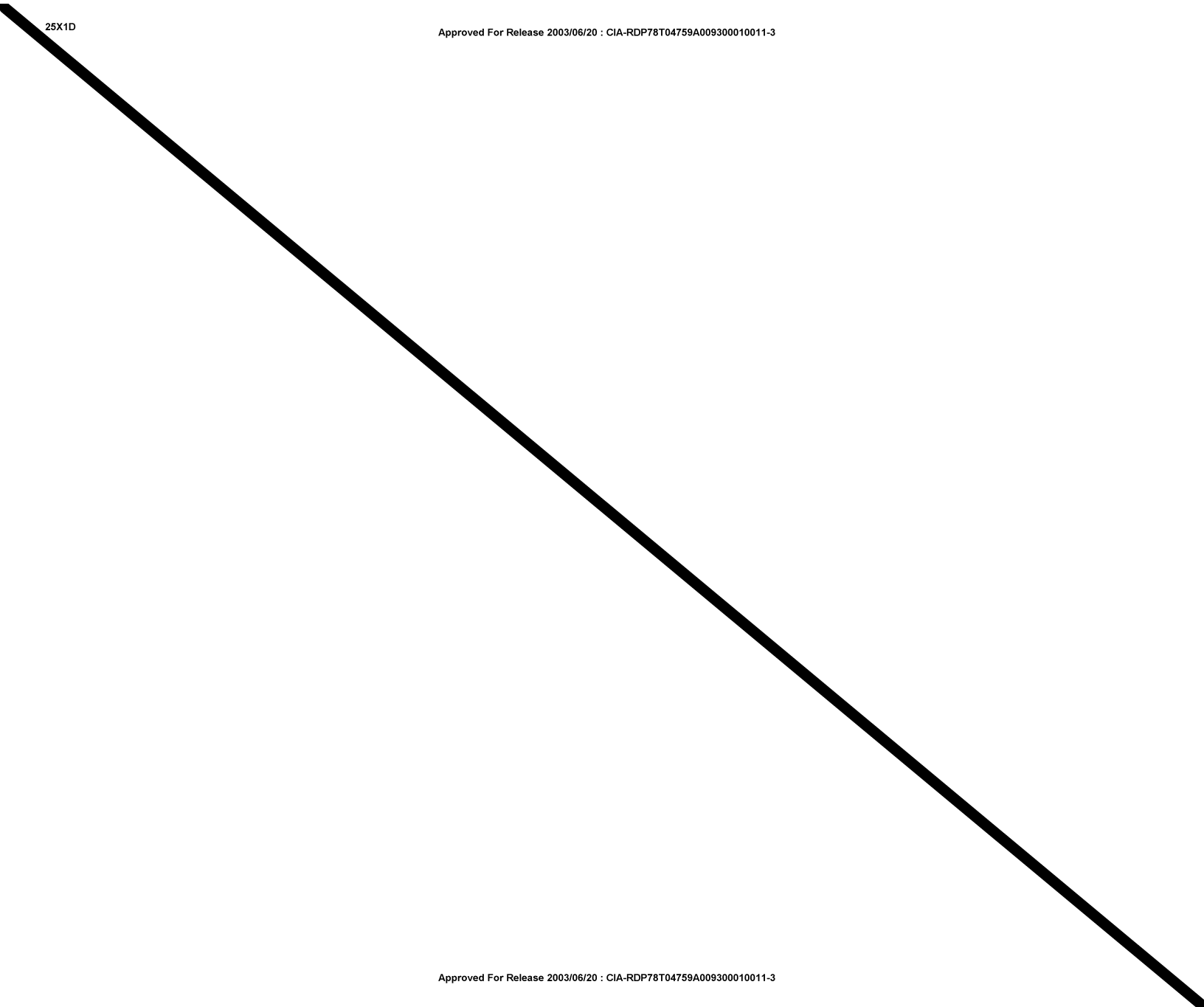
FIGURE 7. CONFIGURATION OF A RIGID VERTICAL RADIATOR.



25X1

FIGURE 8. FOUNDATION SCREEN AND FEEDING OF A BASE-INSULATED VERTICAL RADIATOR.

25X1



Approved For Release 2003/06/20 : CIA-RDP78T04759A009300010011-3

NOTE: The radial lines are not true length lines on this drawing due to the position on the tower
Vertical distances have an accuracy of ± 5 feet
Prepared from ground photograph of Krasnyy Bor facility
supplemented by [redacted] otograph of Kurgan Tyube facility

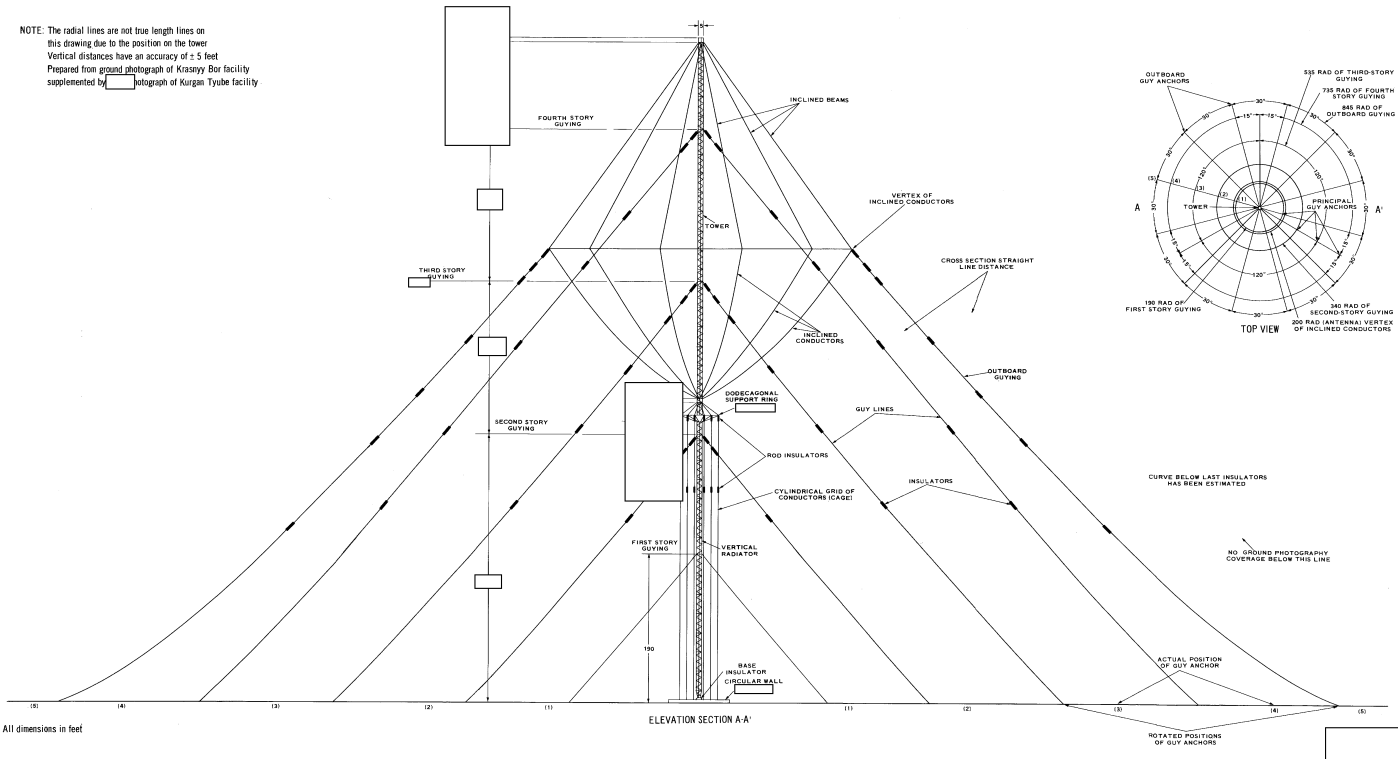
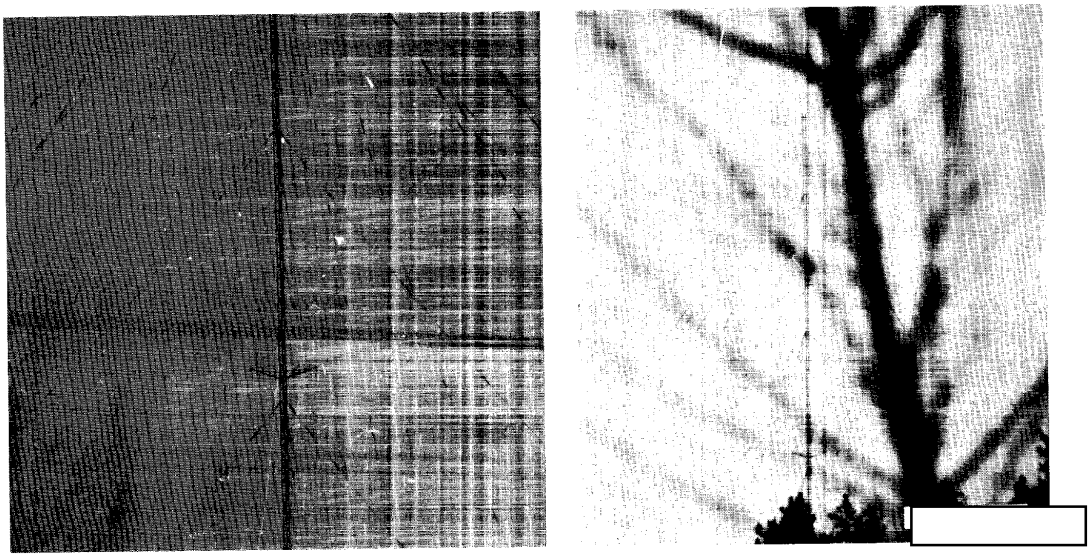
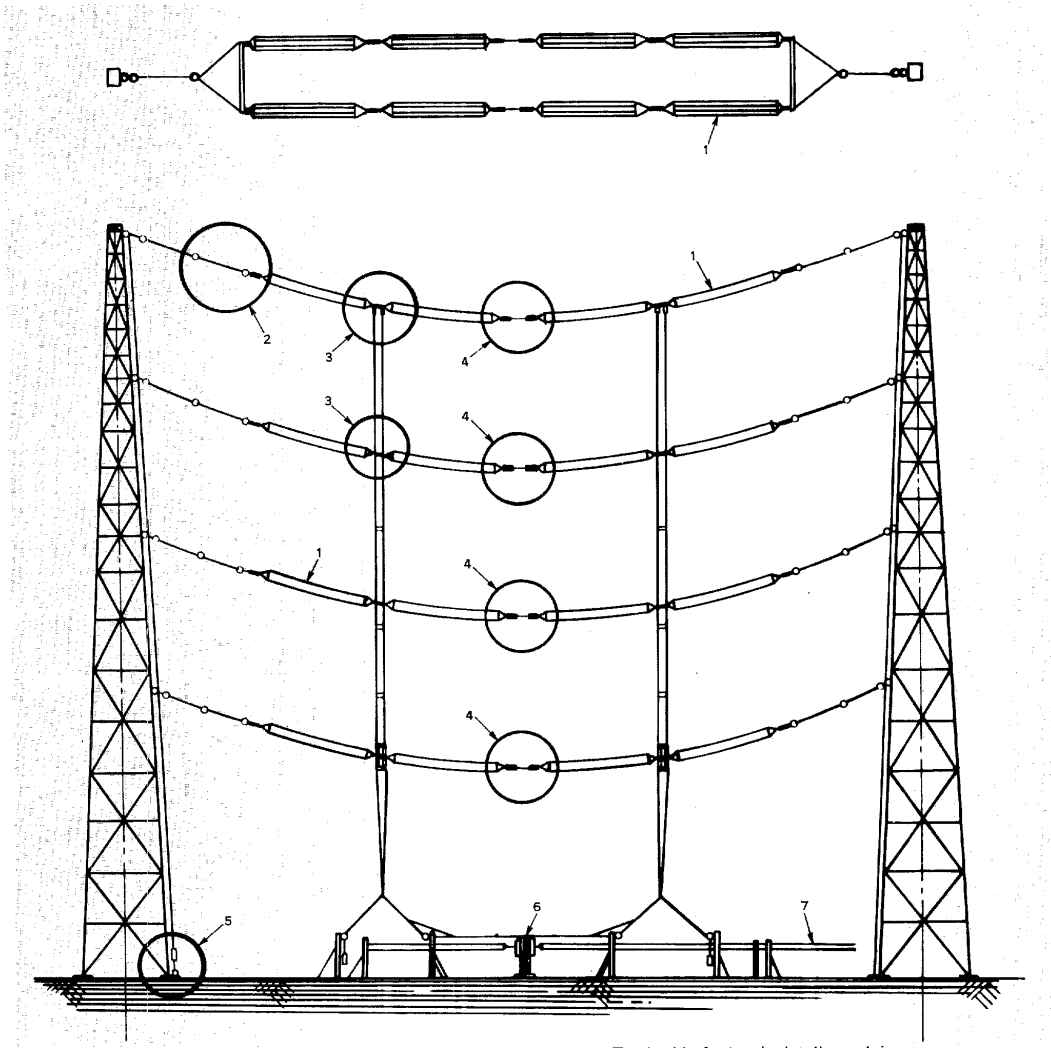


FIGURE 10. DETAILS OF A VERTICAL RADIATOR.



25X1

FIGURE 11. GROUND PHOTOGRAPHY OF A VERTICAL RADIATOR (KRASNYY BOR HF COMMUNICATIONS FACILITY POPOVKA).



1. Broadband dipole
2. Spreader and harness assembly
3. Feeder connection points
4. Interconnecting support cable
5. Turnbuckle for tensioning the curtain
6. Transmission direction switch
7. Transmission line

25X1

FIGURE 12. EXAMPLE OF A STERBA CURTAIN ARRAY.

Associated Antennas

Figures 12 and 13 are examples of curtain arrays and rigid dipole arrays which have been mentioned in the facility description as being collocated, associated antennas.

Part II--Deployed Facilities

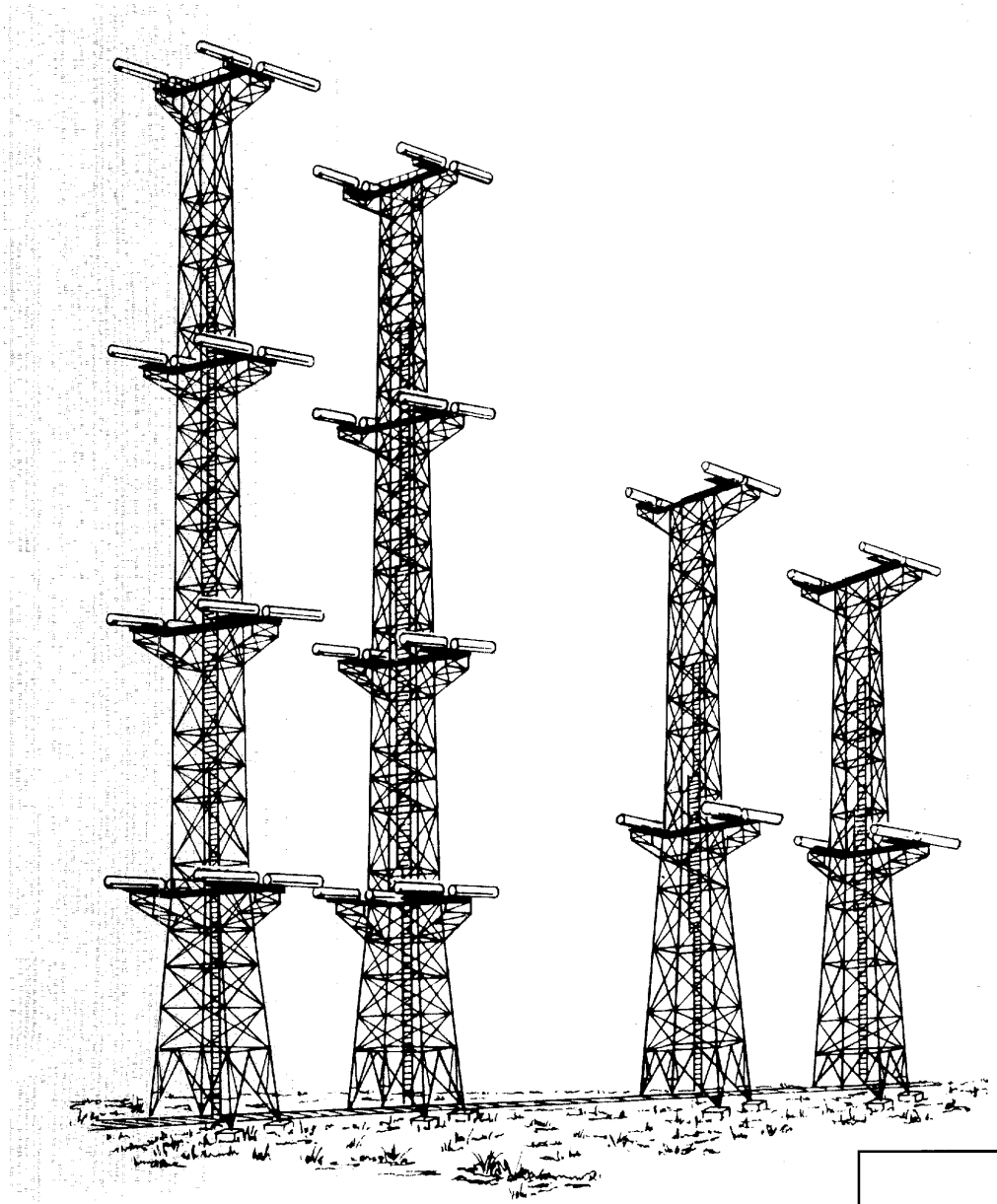
The directions of propagation of all linear arrays discussed in Part II of the report are given in Figure 14. Mensuration is included on Table 1.

Angarsk HF Communication Facility

The Angarsk HF Communication Facility, a linear array facility, is located 11 nm southwest of Angarsk and 20 nm south of Usolye-Sibirskoye at an approximate elevation of 1,600 feet (Figure 15). The site is on relatively flat terrain, with some slight roll and fairly dense vegetation.

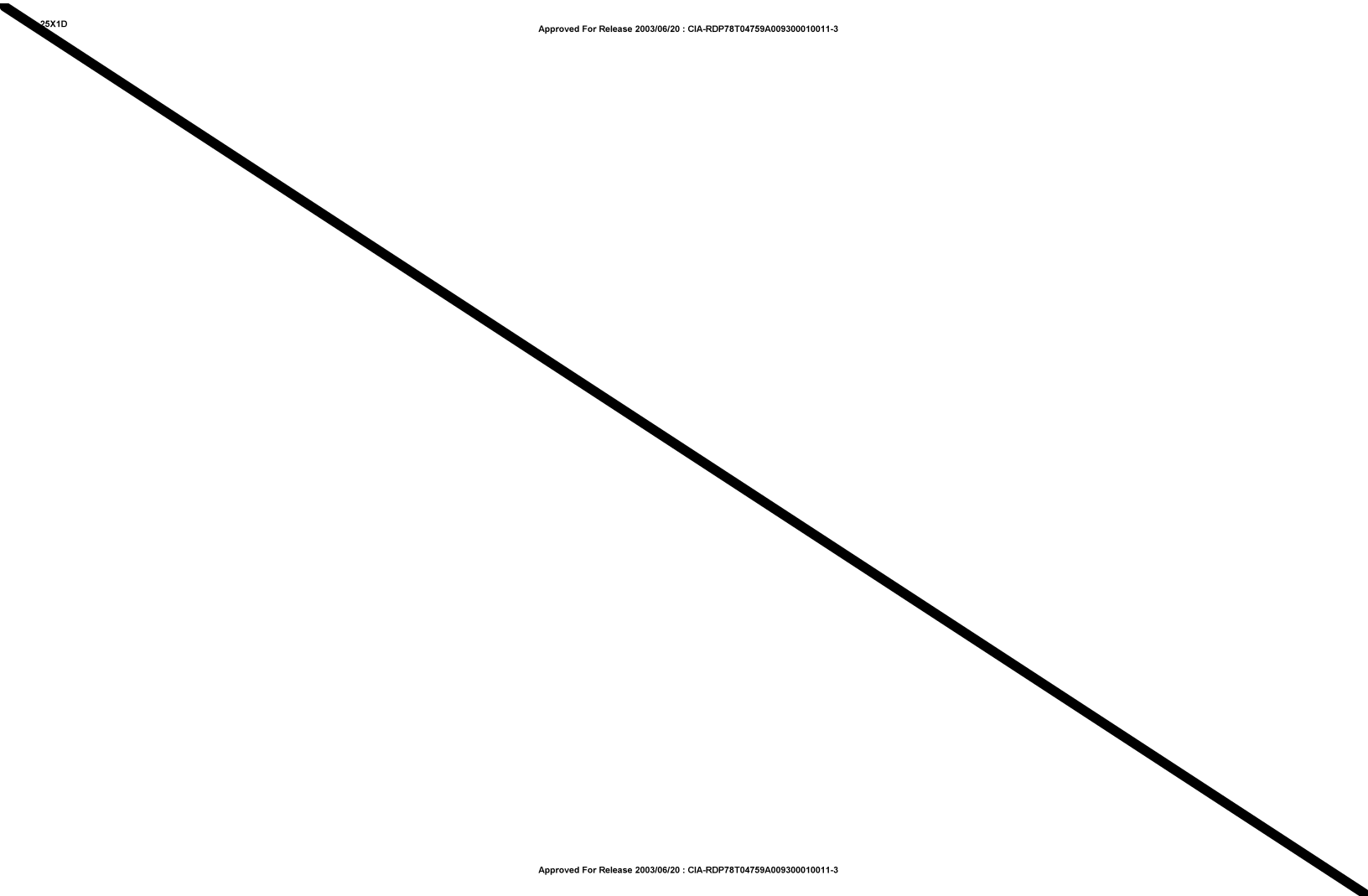
General Description. The support area is positioned at the northernmost tip of the facility. It is somewhat small, and contains only five general support buildings.

A substation has been constructed just southeast of the support area, along the trapezoidal main service road. Photography indicates this substation is fed by a 110-



25X1

FIGURE 13. EXAMPLE OF A RIGID DIPOLE ARRAY.



Approved For Release 2003/06/20 : CIA-RDP78T04759A009300010011-3

25X1D 25X1D 25X1

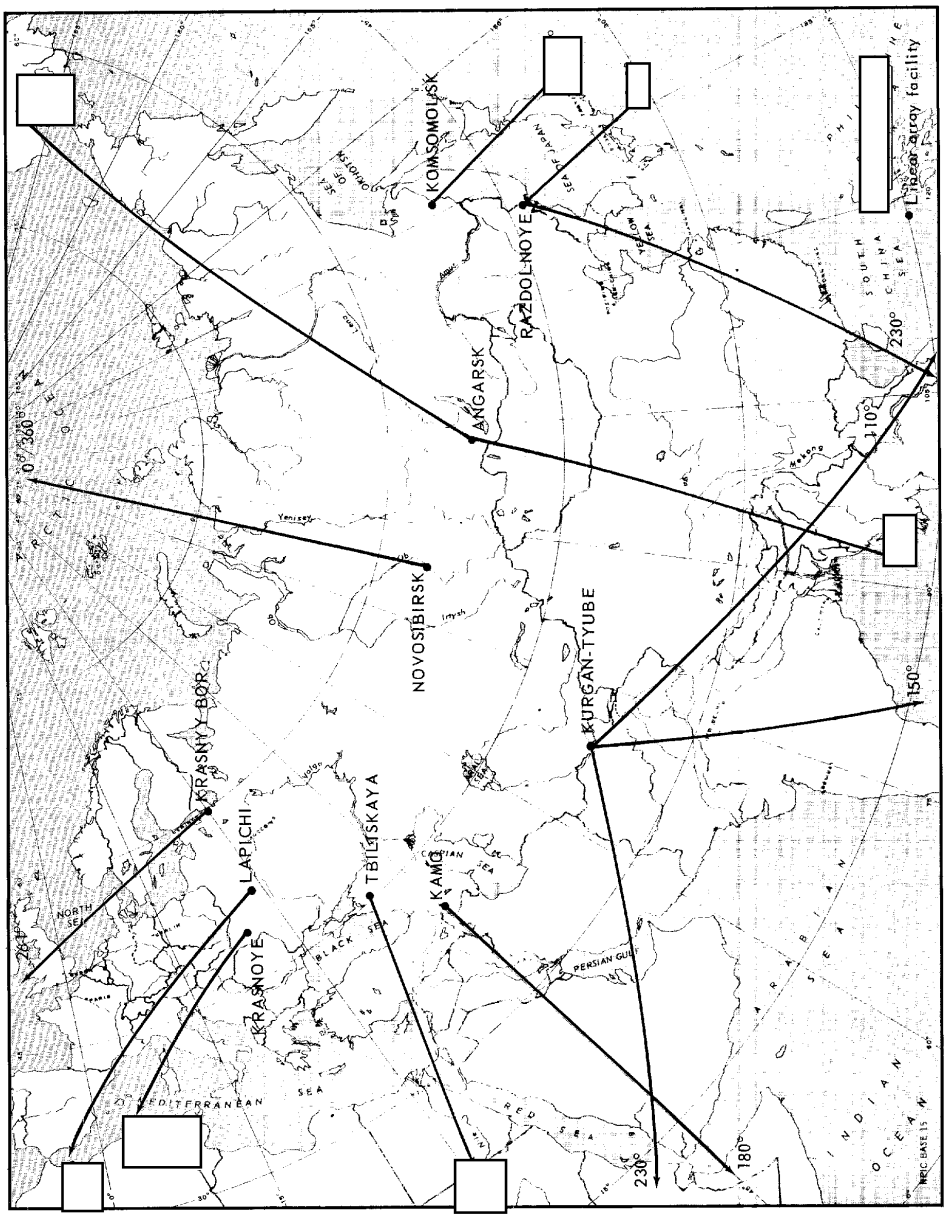


FIGURE 14. LINEAR ARRAY PROPAGATION CHART.

25X1D 25X1D 25X1D

25X1

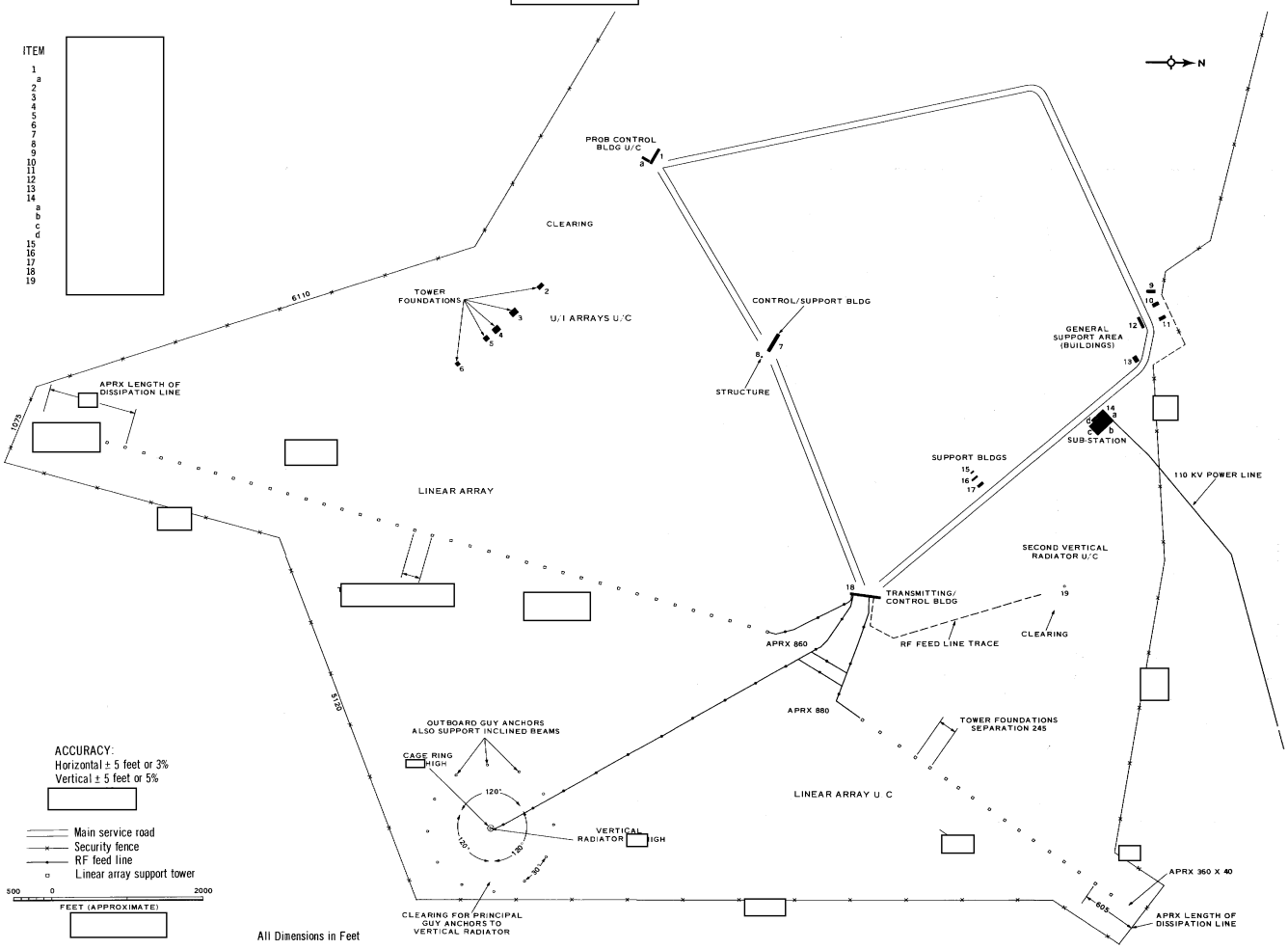


FIGURE 15. ANGARSK HF COMMUNICATIONS FACILITY.

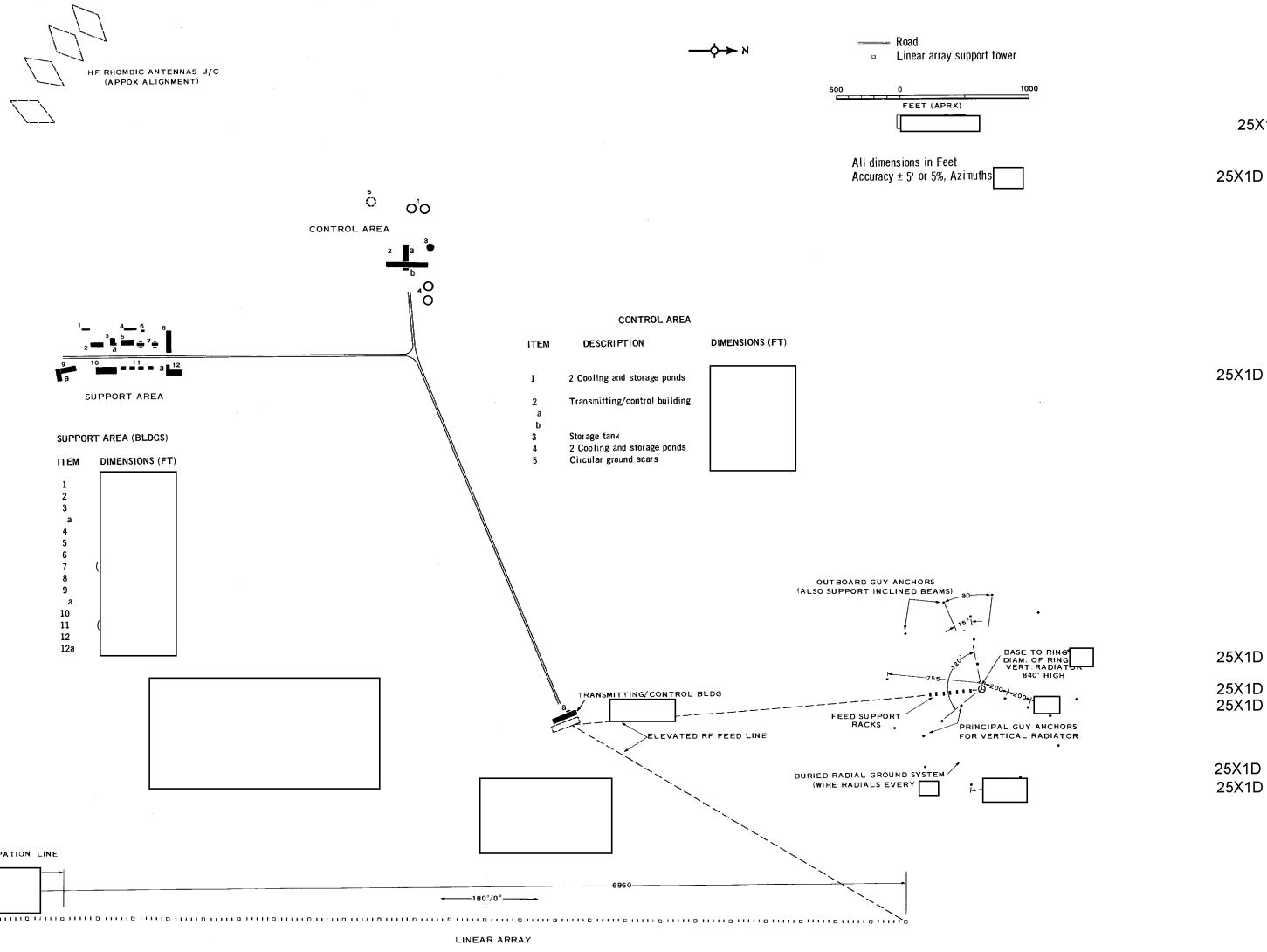


FIGURE 16. KAMO HF COMMUNICATIONS FACILITY.

kilovolt (kv) electrical power line entering from a northeast direction. Also along the service road is one transmitting/control building, one control/support building, and a probable control area under construction. The easternmost building, which is the above-mentioned transmitting/control building, serves both the linear arrays and vertical radiators. Its site has been well selected for the purpose: a 17-tower linear array originates just east, a 36-tower linear array which is [redacted] is just south, and a vertical radiator 25X1D
is a short distance north. The apparent firing directions of the linear arrays are [redacted] 25X1D
25X1D [redacted] respectively. The array with the [redacted] firing direction has no signifi- 25X1D
cant vertical obstructions for about 20 nm. The array with the [redacted] azimuth has no 25X1D
significant vertical obstructions for about 6 nm (a slight vertical obstruction occurs about 6 nm out which amounts to only 1 percent rise). On the west side of the southernmost linear array, a scar became apparent on [redacted] The scar is 25X1D
generally linear with a slight dogleg at one end, and contains five tower footings which are indicative of Sterba curtain array tower footings.

Chronology. This facility was not present on [redacted] It was 25X1D
first identified on photography of [redacted] At this sighting the 25X1D
facility was in the early-to-mid stages of construction, with one linear array and one vertical radiator nearly complete. Re-examination of photography from [redacted]
25X1D [redacted] revealed that construction of the main support area was just beginning. Clearing for the service road was also detected on this coverage. On [redacted] 25X1D
25X1D [redacted] a second linear array and a second vertical radiator position were observed. The latest photographic coverage used in the analysis of the facility, that of [redacted] 25X1D
25X1D [redacted] shows a new area under construction which includes several tower footings which may be for Sterba curtain arrays. These footings do not have the characteristics of linear array footings. The status of the facility at that time ([redacted] was that 25X1D
one linear array was complete, the second linear array was nearing completion, the first vertical radiator was complete, and there had been no progress on the second vertical radiator. In fact, the position for the second vertical radiator observed on earlier coverage
25X1D cannot be identified on [redacted]

Kamo HF Communications Facility

The Kamo Facility, a linear array facility, is located 6 nm northeast of Kamo, on a small peninsula in Lake Sevan at an approximate elevation of 6,500 feet (Figure 16). The site is relatively flat with a low growth of vegetation.

General Description. Basic components of the Kamo Facility include one typical 26-tower linear array, one typical vertical radiator, two transmitting/control areas, an HF rhombic antenna field containing approximately six antennas under construction at the date of latest coverage, and a general support area. No security fence could be accurately defined; however, indications are that one exists.

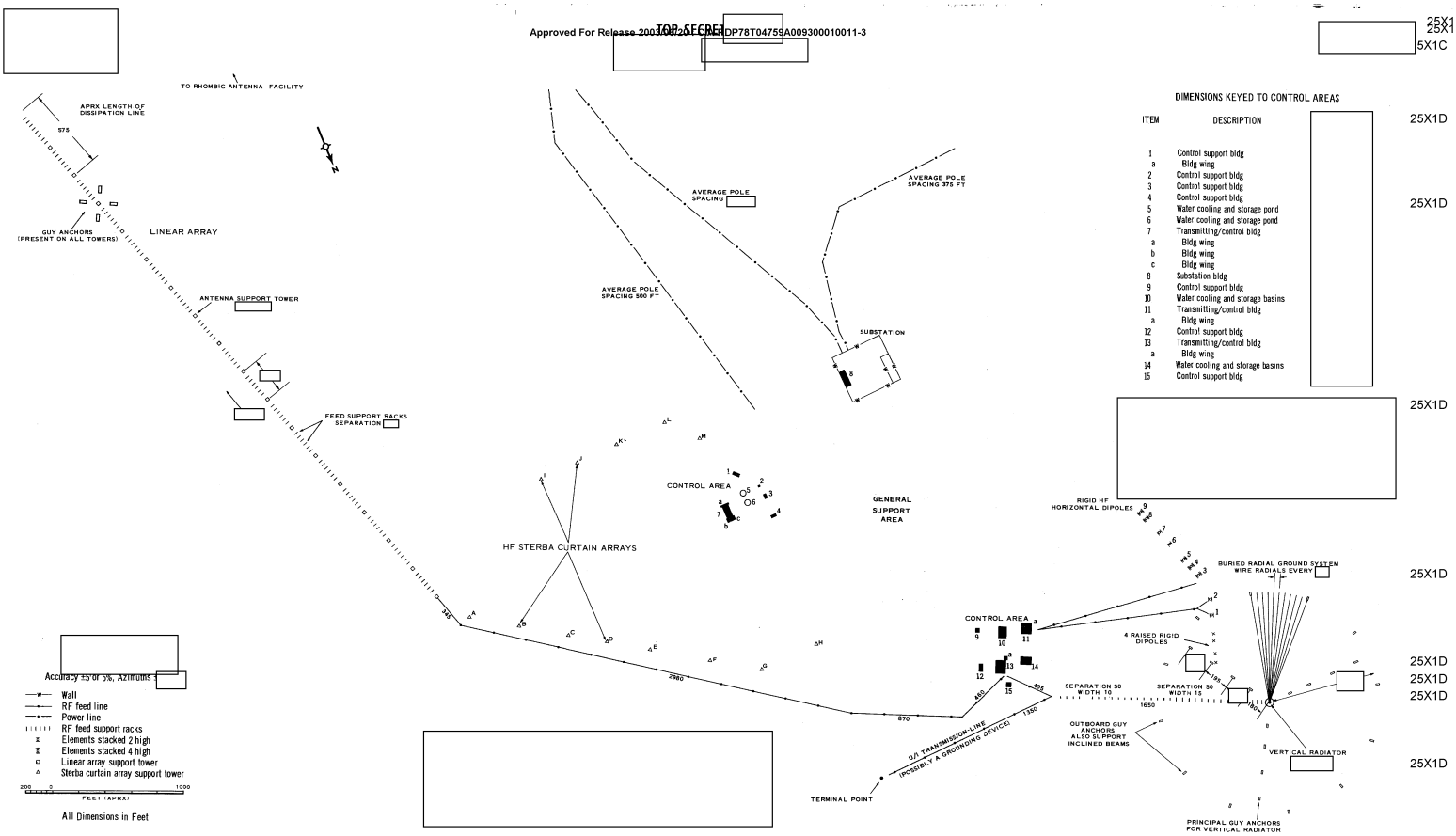
The transmitting/control area nearest the linear array and vertical radiator also feeds those two antennas. In the latter case, the feed extends from the control building to the north end of the array, then travels south down the center of the array which is oriented at 180 degrees (the direction of propagation), and finally terminates beyond the most southernly tower in a dissipation line. There is no significant vertical rise in the terrain for at least 15 nm. Two small probable switching areas are visible on the east side of the transmitting/control building.

The second transmitting/control area, still under construction, is located southwest of the other control area. The T-shaped transmitting/control building here has four adjacent cooling ponds and one storage tank which apparently will be buried. This building probably will house most of the power amplifying equipment in addition to controlling the HF rhombic antennas which are presently under construction in the 25X1D
southwest corner of the facility.

Chronology. Kamo HF Communications Facility was not present on [redacted]
25X1D [redacted] It was first identified on [redacted] at which time one 25X1D
linear array, one vertical array, one control area, and a general support area were externally complete or nearly complete.

25X1D Earlier photography, [redacted] shows the facility in the early 25X1D
stages of construction with 15 of the linear array towers in place and an adjacent transmitting/control area begun. No evidence of a vertical radiator was seen. [redacted]
25X1D [redacted] the facility was in the early-to-mid stages of construction, with 20

25X1



DIMENSIONS KEYED TO CONTROL AREAS

ITEM	DESCRIPTION
1	Control support bldg
a	Bldg wing
2	Control support bldg
3	Control support bldg
4	Control support bldg
5	Water cooling and storage pond
6	Water cooling and storage pond
7	Transmitting/control bldg
a	Bldg wing
b	Bldg wing
c	Bldg wing
8	Substation bldg
9	Control support bldg
10	Water cooling and storage basins
11	Transmitting/control bldg
a	Bldg wing
12	Control support bldg
13	Transmitting/control bldg
a	Bldg wing
14	Water cooling and storage basins
15	Control support bldg

FIGURE 17. KOMSOMOLSK HF COMMUNICATIONS FACILITY SOUTH.

linear area towers in place and six lying on the ground. Judging from progress made between [redacted] the installation was probably first under construction [redacted] all 26 towers of the linear array were in place, but the feedracks between each tower were still in the process of being erected. Clearings for a vertical radiator and its feed were also present at this time.

[redacted] was the first larger scale coverage of the facility which revealed new construction including a second, larger, control area and an HF rhombic antenna field under construction. Foundation work for the transmitting/control areas was present on [redacted]

[redacted]

Komsomolsk HF Communications Facility, South

Komsomolsk, a linear array facility located 5.5 nm northwest of the city of Komsomolsk, is positioned at an elevation of approximately 300 feet (Figure 17). The site itself is relatively flat, but the surrounding terrain consists of rolling hills, except in a south-southeast direction, which is nearly flat. The linear array is oriented in a southeast direction.

General Description. The facility is comprised of one linear array; one MF vertical radiator, located in the northwest corner of the facility; nine arrays of HF rigid dipoles, each array separately tower-mounted and located adjacent to the vertical radiator; an HF Sterba curtain installation containing 11 Sterba curtain arrays situated in two groups, one group containing four and the other seven; two transmitting/control areas; a general support area; and an electrical power substation.

It should be pointed out that the Komsomolsk area has a number of separate communications facilities which include MF radiators and numerous HF antennas such as rhombics.

The linear array contains 17 towers which support the overhead array of horizontal curtains. The towers, which are normally self-supporting have been guyed in a four-way manner indicating an apparent bearing soil problem. This is the only known linear array which uses guying. All towers reach an elevation of [redacted] and are points on a straight line oriented [redacted] The azimuth of propagation is probably [redacted]

Figure 17 delineates the plan view of the MF (medium frequency) radiator taken from good quality photography which defines this geometry.

Rigid HF dipoles have been used for directive broadcasting for some time in the Soviet Union. Five of the nine arrays at this facility have four short dipoles on a level and are stacked four high. The remaining four arrays are stacked two high with four longer dipoles on each level (Figure 11).

High frequency Sterba curtain arrays have also been used for directive broadcasting for some time, with considerably more popularity than the rigid dipoles. They are found at almost every major communications center across the Soviet Union. Those installed here are typical of those shown in Figure 12.

The centrally located transmitting/control area, which contains one transmitting/control building, two cooling ponds, and several control support buildings, appears to serve only the Sterba curtain arrays. The remaining control area on the western side of the facility includes two transmitting/control buildings, two large water-cooling and storage basins, and several control support buildings. It is this control area that serves the rigid dipole arrays, the linear array, and the vertical radiator.

Chronology. The Komsomolsk facility was first observed on [redacted] Lack of coverage during the [redacted] precludes fixing the periods of early and midstage construction. [redacted] the facility contained a linear array, where most of the towers appeared to be in place; a dissipation line scar; feedlines under construction; a vertical radiator under construction; a completed Sterba curtain array field; and a tower-mounted rigid dipole installation containing approximately 13 towers. Transmitting/control buildings were also present.

On [redacted] the facility appeared to be externally complete and nearly the same as it is today, except that the radial ground system at the vertical radiator site was still under construction. It was also noted on this coverage that four of the rigid dipole towers had been removed to make room for the radial ground system.

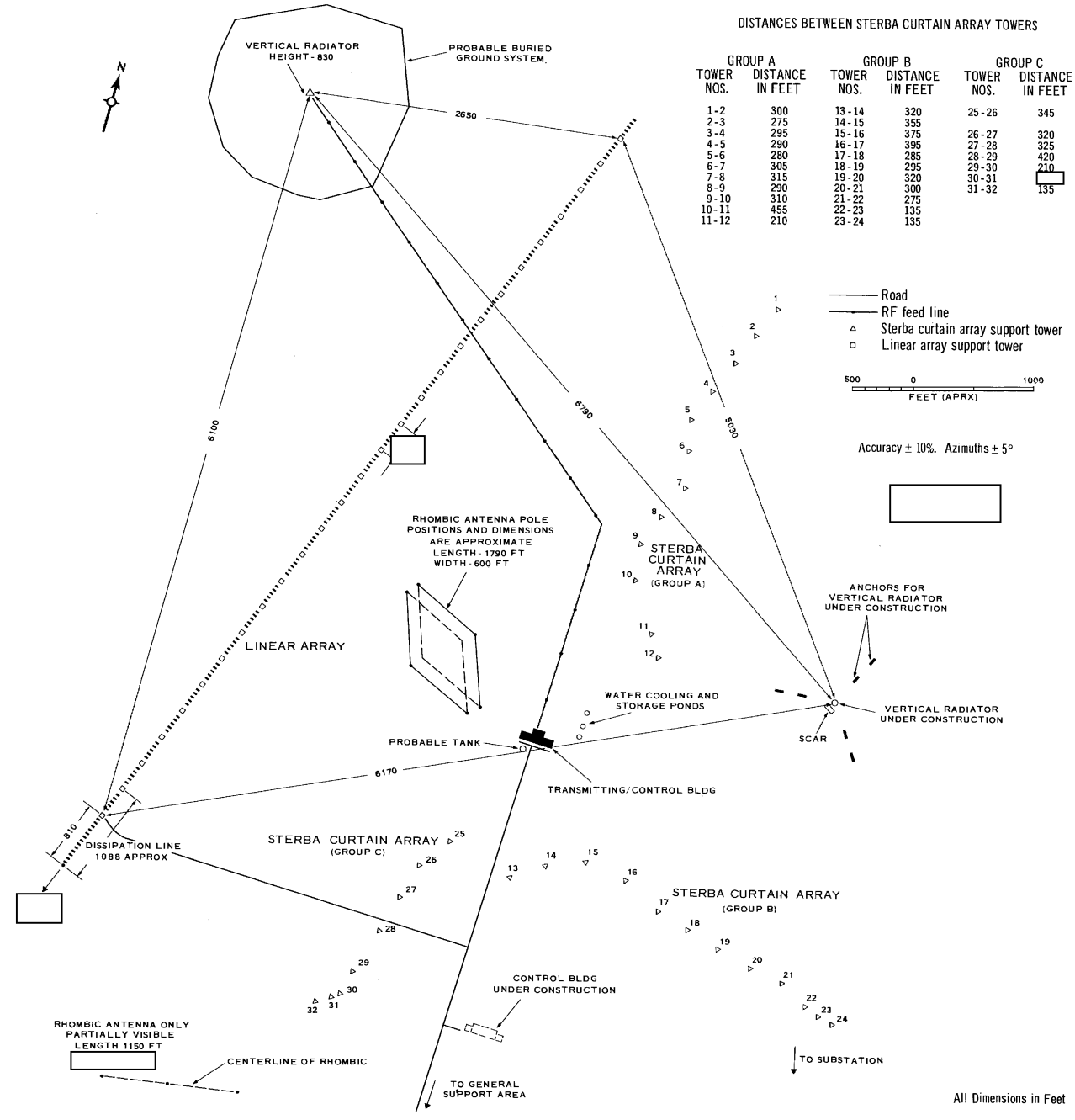


FIGURE 18. TBILISSKAYA HF COMMUNICATIONS FACILITY.

The latest photography used in the analysis of this facility is 25X1D

Tbilisskaya HF Communication Facility

The Tbilisskaya Facility, formerly known as Krasnodar, is located 8 nm northwest of Tbilisskaya where terrain variations are minor (Figure 18). There are no significant vertical obstructions in any direction. Site elevation is approximately 300 feet, with a low cover of vegetation in an area formerly under cultivation.

General Description. Components of the facility are as follows: one 27-tower linear array; one completed MF vertical radiator and one MF vertical radiator under construction; two HF rhombic antennas; 29 HF Sterba curtain arrays; one transmitting/control building; one control building under construction; an electrical power substation; and a general support area.

The linear array is typical in design, being end fed and terminated in the same manner as all the linear arrays covered in this report. The antenna is thought to be firing (propagating) towards the terminated end at an azimuth of The estimated 25X1D basic frequency of 3.66 MHz is based on a half-wave dipole element. If these are assumed to be quarter-wave dipoles, the frequency would be about 1.83 MHz. Multiples of this frequency could extend throughout the HF band. Tower heights have not been included on Table 1 because the coverage has not been of adequate interpretability; however, an estimated height of 130 to 140 feet is reasonable.

The completed vertical radiator is typical of the example discussed in the antenna design section of this report, except the ground system is somewhat irregular in shape. The second vertical radiator is under construction and appears typical in design. The tower (radiator) has not yet been erected.

The Sterba curtain arrays are similar to those shown on Figure 12. They are positioned here generally around the transmitting/control building. With respect to positioning in general, it should be observed that no antennas have been placed off the ends of the linear array. This tends to support the end-fire theory for the linears.

Three cooling and storage ponds and one probable tank are located adjacent to the transmitting/control building. All of the above features are located within a security fence, except the electrical power substation, which is separately secured. 25X1D

Chronology. First sighting of the Tbilisskaya facility occurred on 25X1D

Construction was in the mid- to late-stages, with the linear array nearly complete (all towers in place), preparation for the erection of the vertical radiator was underway, scarring for feed lines to both antennas was present, and the transmitting/control and general support areas were under construction. 25X1D

A review of photography reveals that construction did not begin until after 25X1D However, construction was in the very early stages with scarring present on The facility was probably first under construction 25X1D in the early part of 25X1D

On the linear array and vertical radiator appeared to be complete. The control building was present, but the adjacent cooling ponds were not present. Rhombic antenna and HF Sterba antenna footings were observed at that time.

Photography of is the most recent photography used in the interpretation of this facility. The entire facility appears to be complete, with the exception of a second control building which is in the late stage of construction and a new vertical radiator which is in the early stages of construction. 25X1D

Krasnoye HF Communication Facility

The Krasnoye Facility, located 2.5 nm east-southeast, is probably the best known facility with respect to antenna details of those covered in this report (Figure 19). This is principally due to the amount of available ground photography of this facility. It is therefore the basis of much of the detailed analysis presented under the antenna design section.

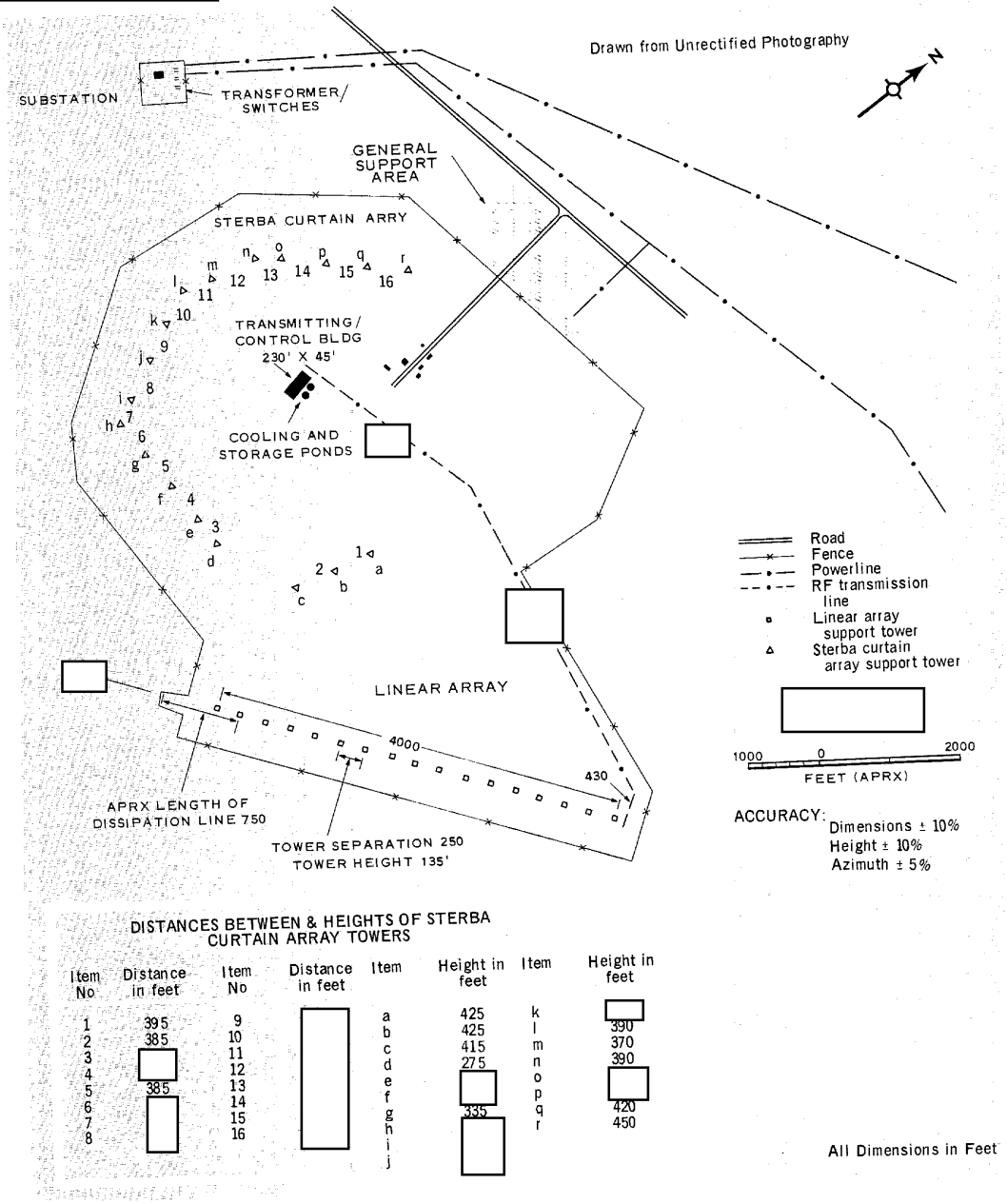
Positioned on flat terrain at an elevation of approximately 350 feet that requires drainage ditches to carry off excess water, there is very little vegetation because the land was formerly under cultivation. Approximately 7 nm to the south and east a mountainous area begins, but there is no masking in the expected azimuth of propagation of the linear array for about 15 to 20 nm.

General Description. Principal components at Krasnoye include: a 17-tower linear array; 14 HF Sterba curtain arrays; a transmitting/control building with two adjacent cooling and storage ponds; a general support area and a nearby, associated, electrical power substation. All are within one common security fence, except for the electrical power substation which is separately secured outside the main area.

Here again the linear array is end fed, with the feed entering from the northeast end and terminating at the southwest end. The azimuth is [redacted] The antenna support towers, 135 feet in height, are points along this azimuth. 25X1D

As in the previous cases, the HF Sterba curtain arrays are similar to those shown on Figure 12 and propagate broadside to the array, i.e., perpendicular to a line connecting each pair of towers.

Chronology. No attempt was made to determine when this facility was not present on photography because of its presence as an HF curtain array broadcast facility long before the linear array was constructed. The linear array was constructed after [redacted] 25X1D
25X1D [redacted] and the Sterba curtains were operational prior to [redacted] 25X1D



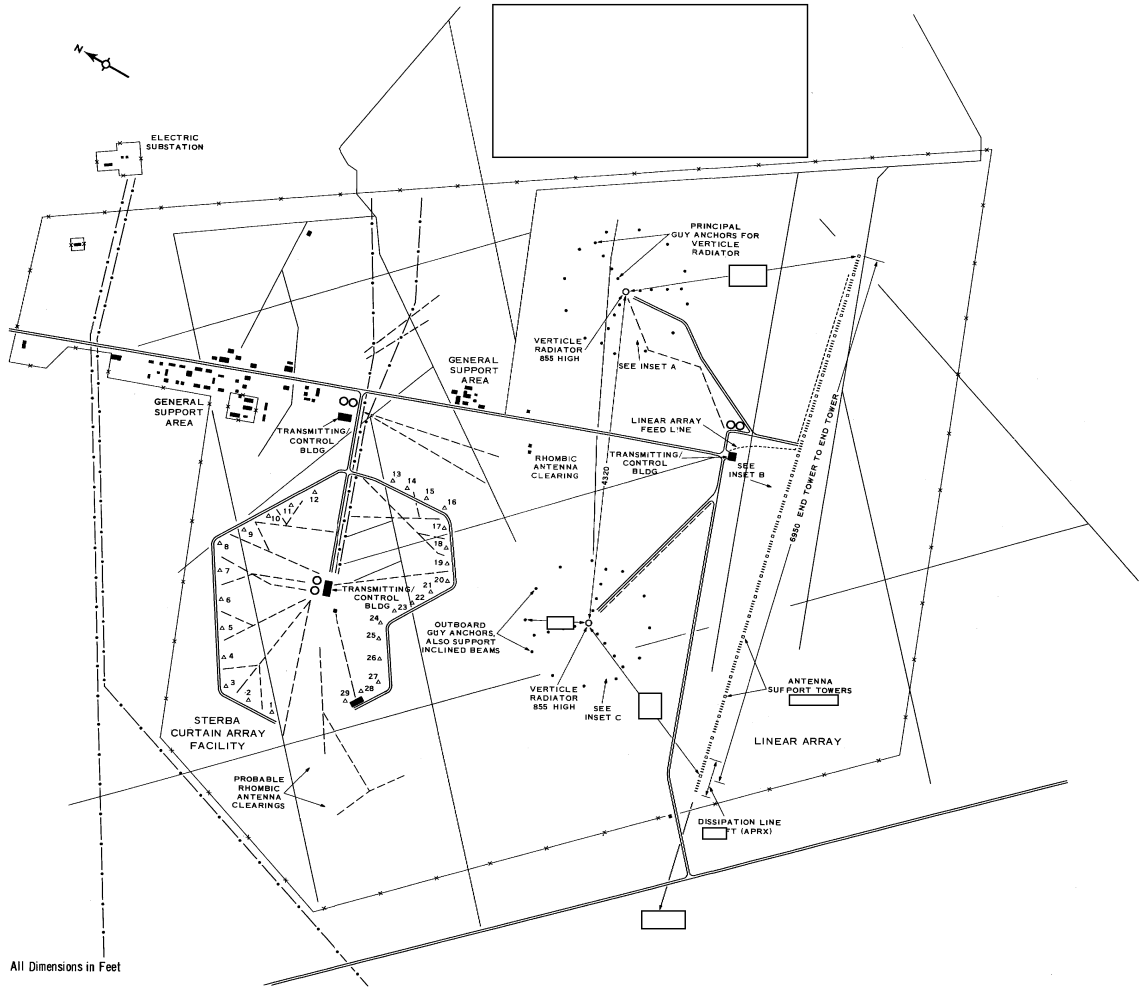
DISTANCES BETWEEN & HEIGHTS OF STERBA CURTAIN ARRAY TOWERS

Item No	Distance in feet	Item No	Distance in feet	Item	Height in feet	Item	Height in feet
1	395	9		a	425	k	
2	385	10		b	425	l	390
3		11		c	415	m	370
4		12		d	275	n	390
5	385	13		e		o	
6		14		f		p	
7		15		g	335	q	420
8		16		h		r	450
				i			
				j			

All Dimensions in Feet

25X1D 25X1D 25X1D 25X1D 25X1D 25X1D 25X1D 25X1D

FIGURE 19. KRASNOYE HF COMMUNICATIONS FACILITY. 25X1



A

FEED SUPPORT RACK SEPARATION

B

FEED SUPPORT RACK SEPARATION

C

GUY ANCHOR SEPARATION

Drawn from Unrectified Photography
Accuracy ± 10' or 10%, Azimuths ± 5°

Fence
Drainage ditch
Powerline
RF transmission line
Linear array support tower
Sterba curtain array support tower
Water cooling pond

500 0 2000
FEET (APRX)

FIGURE 20. KRASNYY BOR HF COMMUNICATIONS FACILITY POPOVKA.

The linear array was first observed, with only the footings present, on 25X1D A review of earlier photography indicates, however, that terrain preparations were underway prior to on which a very faint outline of the site can be observed. 25X1D

25X1D Ground photography of reveals the linear array to be complete. No new construction has occurred since that time. Photography of 25X1D

25X1D is the latest coverage utilized in the detailed analysis of the Krasnoye Facility.

Krasnyy Bor HF Communication Facility Popovka

Located just south of Krasnyy Bor and about 20 nm southeast of the center of Leningrad, this facility was an HF Sterba curtain array broadcast facility prior to the installation of the linear array and vertical radiator (Figure 20).

Except for the antenna clearings the site is heavily vegetated, and is at an approximate elevation of 150 feet. Rolling terrain prevails here, offering no significant vertical obstruction in any direction.

General Description. Krasnyy Bor consists of one typical 26-tower linear array, two MF vertical radiators, 27 Sterba curtain arrays, two cleared areas for an undetermined number of probable HF rhombic antennas, three transmitting/control areas, a general support area, and a separately secured electrical power substation located to the north and outside the main security fence which surrounds the balance of the facility.

Propagation of the linear array appears to be off the dissipated end, at an azimuth 25X1D The feedlines leave the control building, continue to a point near the antenna, and parallel the antenna to the eastern end. The towers in this array 25X1D

25X1D feet high and have a separation.

As previously mentioned, Sterba curtain arrays are used for HF broadcasting. Here they are placed in a normal manner with groups of supporting towers positioned on lines which form an eight-sided polygon.

Two of the three transmitting areas serve the curtain arrays and rhombic antenna fields. The remaining transmitting area, which includes two cooling and storage ponds, is positioned next to and serves the linear array.

Chronology. A review of photography over this facility shows that at the time of 25X1D first sighting, the linear array was in the early stages of construction. The Sterba curtain arrays were operational at that time; however, work had not commenced on the vertical radiators.

Twenty-six towers supporting the linear array were in place on 25X1D

25X1D Both vertical radiators were in the early stages of construction. All of the antennas

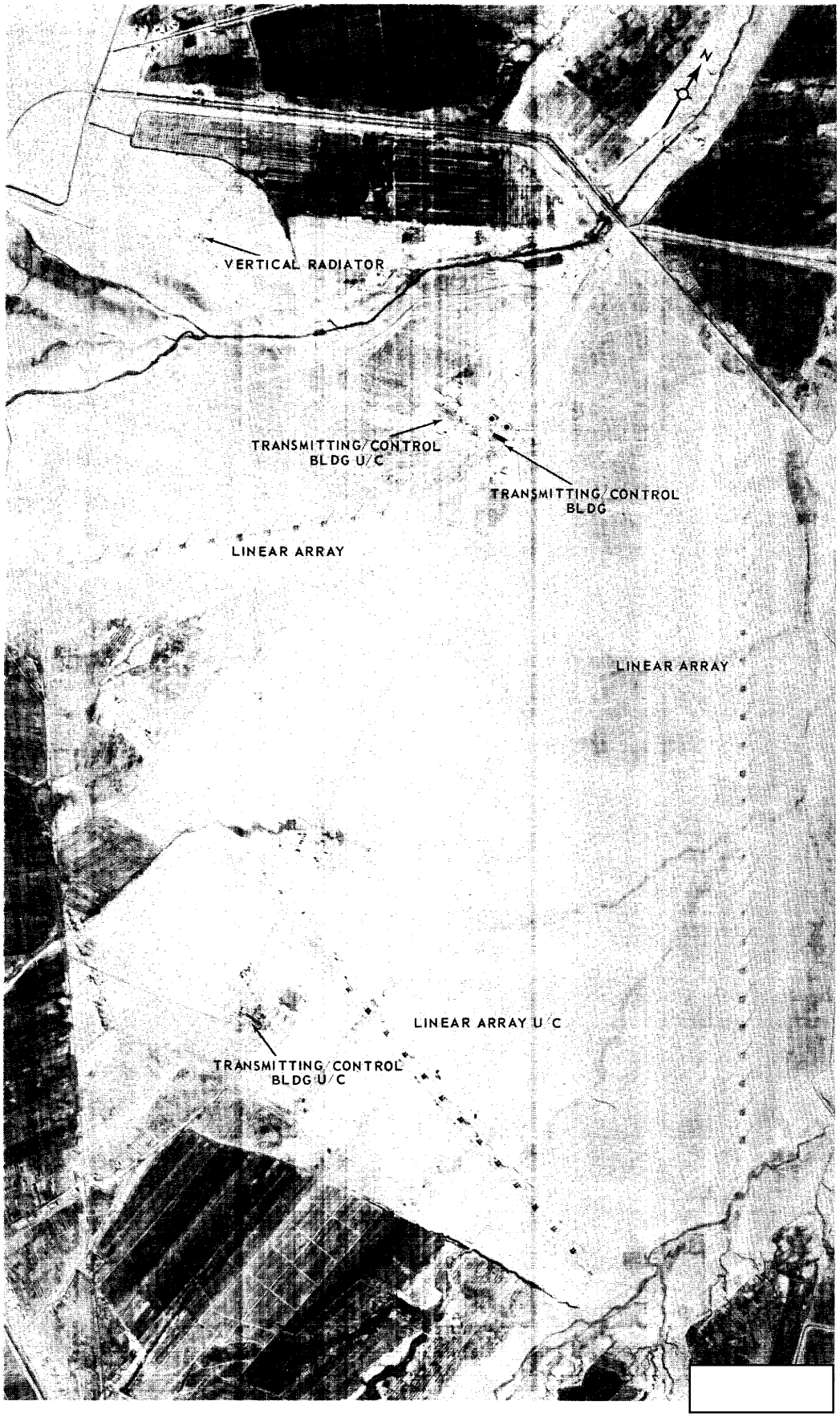
25X1D appear complete on however, the radial ground system, normally present around this type of vertical radiator, had not developed. No significant change has occurred up to which is the latest coverage 25X1D utilized in the detailed analysis of this facility.

Kurgan-Tyube HF Communication Facility

Located 17 nm south of Kurgan-Tyube, this linear facility has the largest number of linear arrays of any of the linear array facilities (Figures 21 and 22). Three such arrays

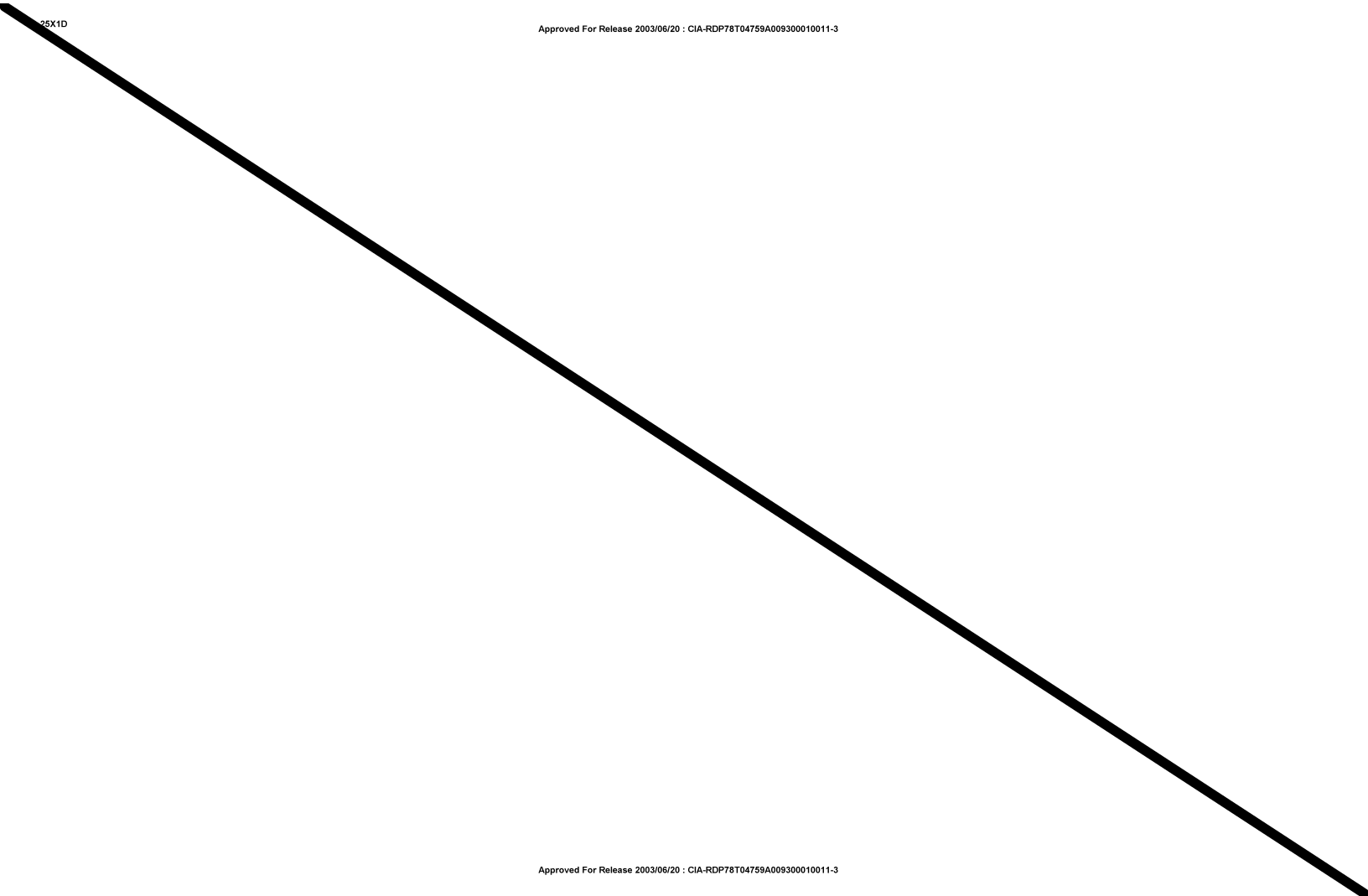
25X1D are situated on flat terrain with an approximate elevation of 1,500 feet. The surrounding area, however, becomes quite rugged.

General Description. The facility contains three linear arrays, one of which is under construction; one MF vertical radiator nearly complete; 12 HF double rhombic transmitting antennas; three transmitting/control areas; two groups of unidentified antenna footings under construction; and a small electrical power substation. New construction on the unidentified arrays consists of anchor positions and tower footings for three three-bay vertically stacked horizontal HF arrays. Each array will be made up of four towers. The end towers each have four anchor positions which are in line with the main axis of the array. All four towers are cross braced by three guy legs on each side of the main axis of the array. Similar HF antenna construction has been observed at the Nikolayev HF Communications Facility.



25X1

FIGURE 21. KURGAN-TYUBE HF COMMUNICATIONS FACILITY.



Approved For Release 2003/06/20 : CIA-RDP78T04759A009300010011-3

The eastern and western linear arrays appear to be complete, having 27 and 12 towers respectively. The 12-tower linear array is the shortest of all the known linear arrays. The 25X1D remaining linear will have 27 towers and lies on the southern side of the facility. This

25X1D . A rectangular grid/trench system is evident on all three linear arrays. On the third, or 27-tower array, the rectangular grid/trench system extends from the first tower of the array to the last and has an approximate width of 2.5 tower spacings. In addition, a radial trench system is under construction at 14 of the towers. Based on the construction of other linear arrays, this trenching appears to be a probable drainage system. However, the possibility that this trenching may contain a type of ground system cannot be overlooked.

The three linear arrays form a triangle in such a manner that none are across or in front of any of the others.

The rhombics are placed in four groups of three. In each group there are two night rhombics and one day rhombic. They can all be identified as transmitting antennas, as evidenced by dissipation lines placed at the propagating ends.

The vertical radiator is of the typical design and is apparently complete, except for a small section of the ground system on the south side where no evidence of radials exists.

Two of the transmitting/control areas lie to the north. The easternmost of the two is complete and serves the two completed linear arrays as well as the rhombic field. The other northern area, when finished, will serve the linear array that is presently under construction. The location of the third transmitting and control area, just south 25X1D of the linear array under construction, might indicate that its purpose would be to serve the adjacent linear array; however, based on it appears that this transmitting area will serve the unidentified antennas under construction on the southwest side of the facility. 25X1D

Chronology. This facility was constructed after First 25X1D identification was made on however, earlier coverage --

25X1D - showed that the facility containing the shorter array was com- 25X1D plete; three towers of the eastern array and the support area were under construction.

25X1D 12 towers of the second array were in place and construction of the radial ground system for the vertical radiator was underway. Mission

25X1D shows that all the towers of the second array had been erected. Footings for the majority of the towers for the third linear array were present on Mission

25X1D The vertical radiator appeared nearly complete at this time, with the 25X1D radiator itself in place.

The latest coverage used in the analysis of this facility was

25X1D At this time the entire installation appeared nearly complete.

Lapichi HF Communication Facility

Lapichi was the first facility observed to contain a linear array; therefore, this type of array, including the vertical radiators, is sometimes referred to as "Lapichi-type array" (Figure 23). The facility is across the river from the town of Lapichi and north of the highway that runs into Bobruysk about 30 nm to the southeast. The site is flat at an elevation of approximately 500 feet, with a considerable amount of swamp in the adjacent areas. Lapichi is somewhat deeper in the interior of the USSR than the majority of the linear array facilities. This is also one of the few facilities that has none of the standard-type HF antennas, such as curtain arrays and rhombic antennas.

General Description. Enclosed within the security fence are one 26-tower linear array, 25X1D two vertical radiators, a transmitting/control area, and an electrical power substation.

Tower height of the linear array is 135 feet. The probable end-fire orientation is degrees, which is in the direction of the dissipation line. It is of typical configuration in every visual respect, including the rectangular area on which the antennas have been constructed. The vertical arrays are also typical; each one incorporates a full radial ground system.

Both the linear and vertical arrays are fed by the same transmitting/control area which includes the transmitting/control building, two cooling ponds, and several control/support buildings.

Chronology. Clearing for the linear array can be observed through a small opening in the clouds with some evidence of construction on the tower foundation on Mission 25X1

This is the first interpretable coverage of the site. On Mission survey work had begun on the vertical array closest to the main road.

Towers of the linear array were up on No work on the vertical arrays was discernible. Both vertical arrays were later seen in the early stages of construction on 25X1D

The entire facility was externally complete on The final coverage utilized in the analysis of this facility is 25X1D 25X1D

Novosibirsk HF Communication Facility Oyash

Of all the linear array facilities, this facility is the least sophisticated from outward appearances (Figure 24). The installation is some 40 nm northeast of the center of Novosibirsk and just 3.5 nm northwest of Oyash. The elevation is approximately 500 feet, with rolling terrain characteristics. The interpretability of photography over this area is quite poor.

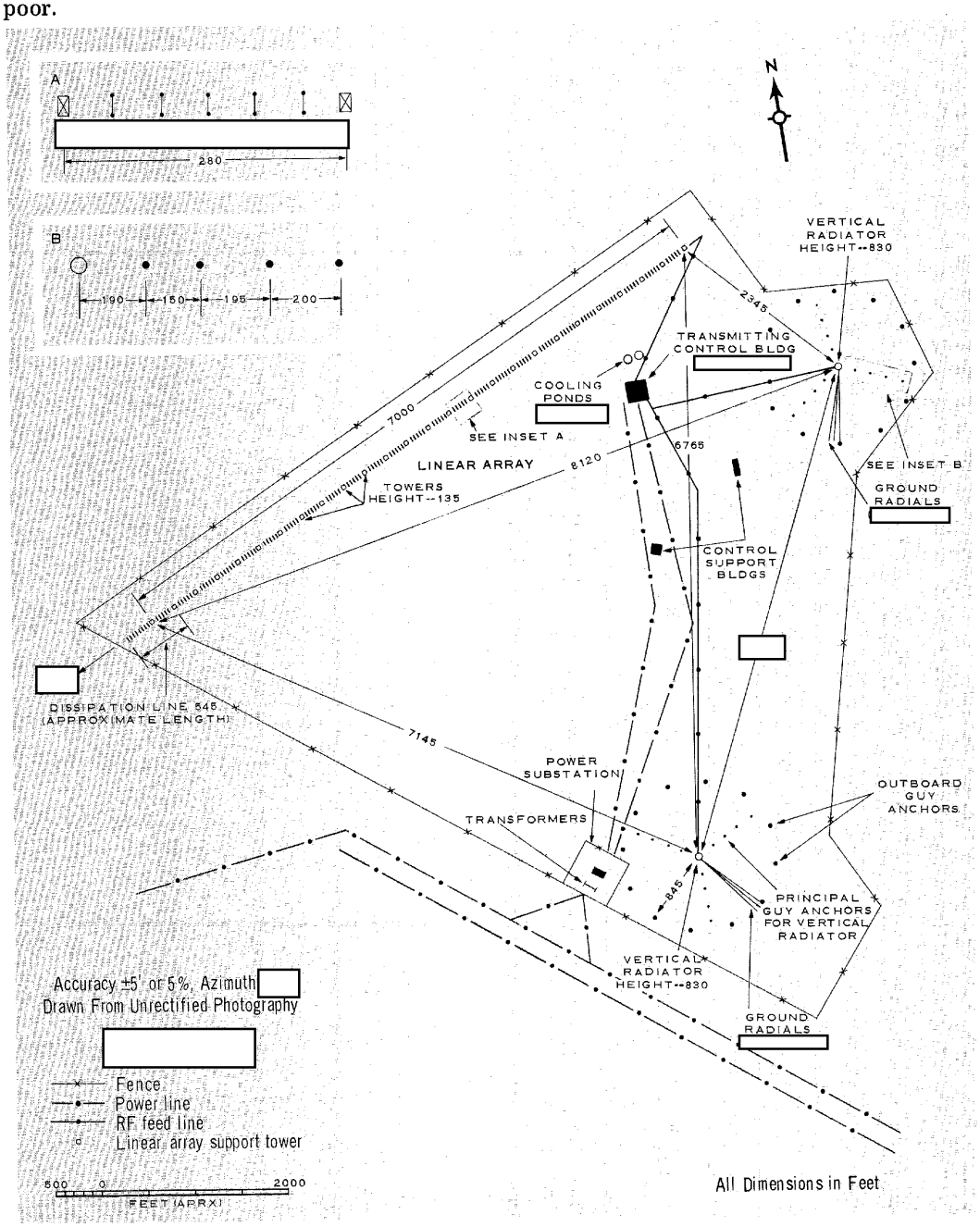


FIGURE 23. LAPICHI HF COMMUNICATIONS FACILITY.

General Description. Novosibirsk contains one 16-tower linear array 145 feet high, one typical radiator under construction, one transmitting/control building, and a general support area. Portions of a security fence can be observed on the south and west sides. A second linear array, oriented 165/345 degrees, and a second control building are now under construction at Novosibirsk, [redacted] 25X1D

Chronology. Photography has established that this facility was constructed subsequent 25X1D to [redacted] On [redacted] this facility was observed 25X1D under construction. At that time the support area was near completion, the linear array was in the early stages of construction with only footings visible, and construction of the vertical array had not yet commenced.

The facility was first reported on [redacted] and at that time all of 25X1D the linear towers were up and the first stage of construction on the vertical radiator was evident.

25X1D [redacted] was the last coverage utilized in the analysis of this installation. The installation appeared to be complete, but the vertical radiator itself could not be observed.

Razdolnoye HF Communications Facility

Razdolnoye HF facility has been constructed along the ridge line of fairly hilly terrain at an approximate elevation of 800 feet (Figure 25). This area is east of the town of Razdolnoye and about 25 nm north of the center of Vladivostok.

This facility was built at least five years prior to any of the other known linear array facilities. It is therefore assumed that this is the prototype for all those that have followed. The subsequent arrays have not changed appreciably from the early arrays. Only differences in support elements have taken place, e.g., the later arrays are placed on better prepared sites.

General Description. The facility contains one 15-tower linear array with an end-fire 25X1D orientation of [redacted] one 25-tower linear array with an end-fire orientation of 230 degrees, one probable low-frequency (LF) hexagonal antenna containing six perimeter 25X1D towers [redacted] and one central tower 295 feet high, one probable HF circular antenna containing approximately 16 poles placed on a circle, one typical vertical radiator, two

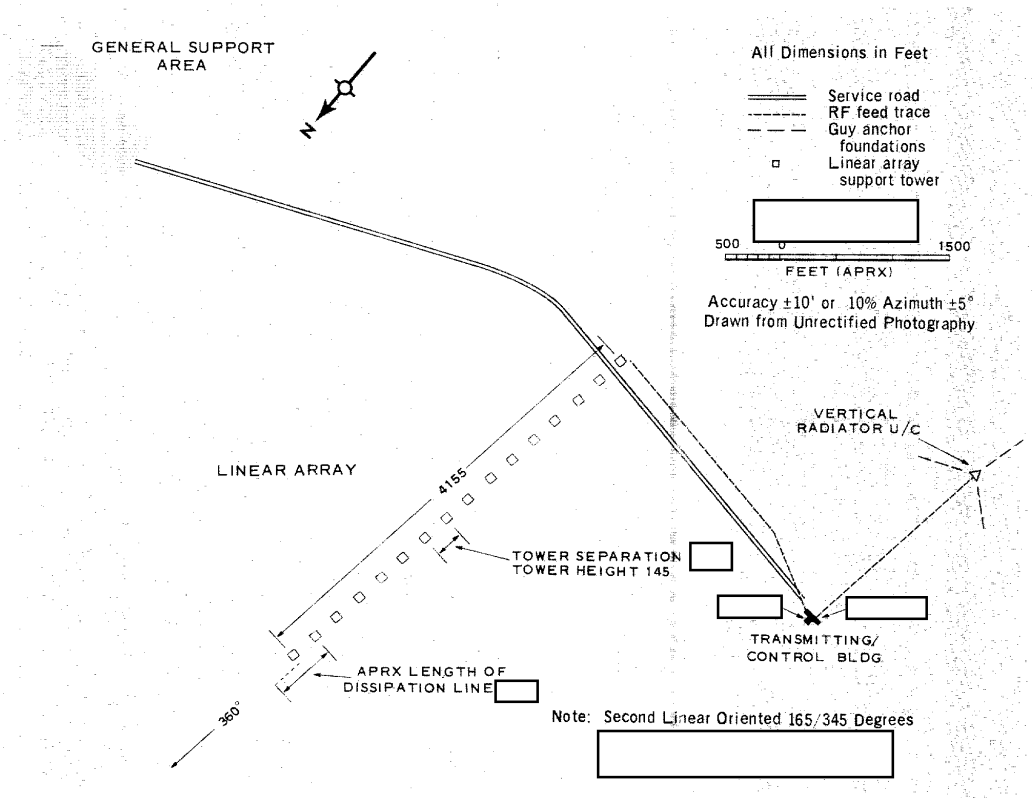
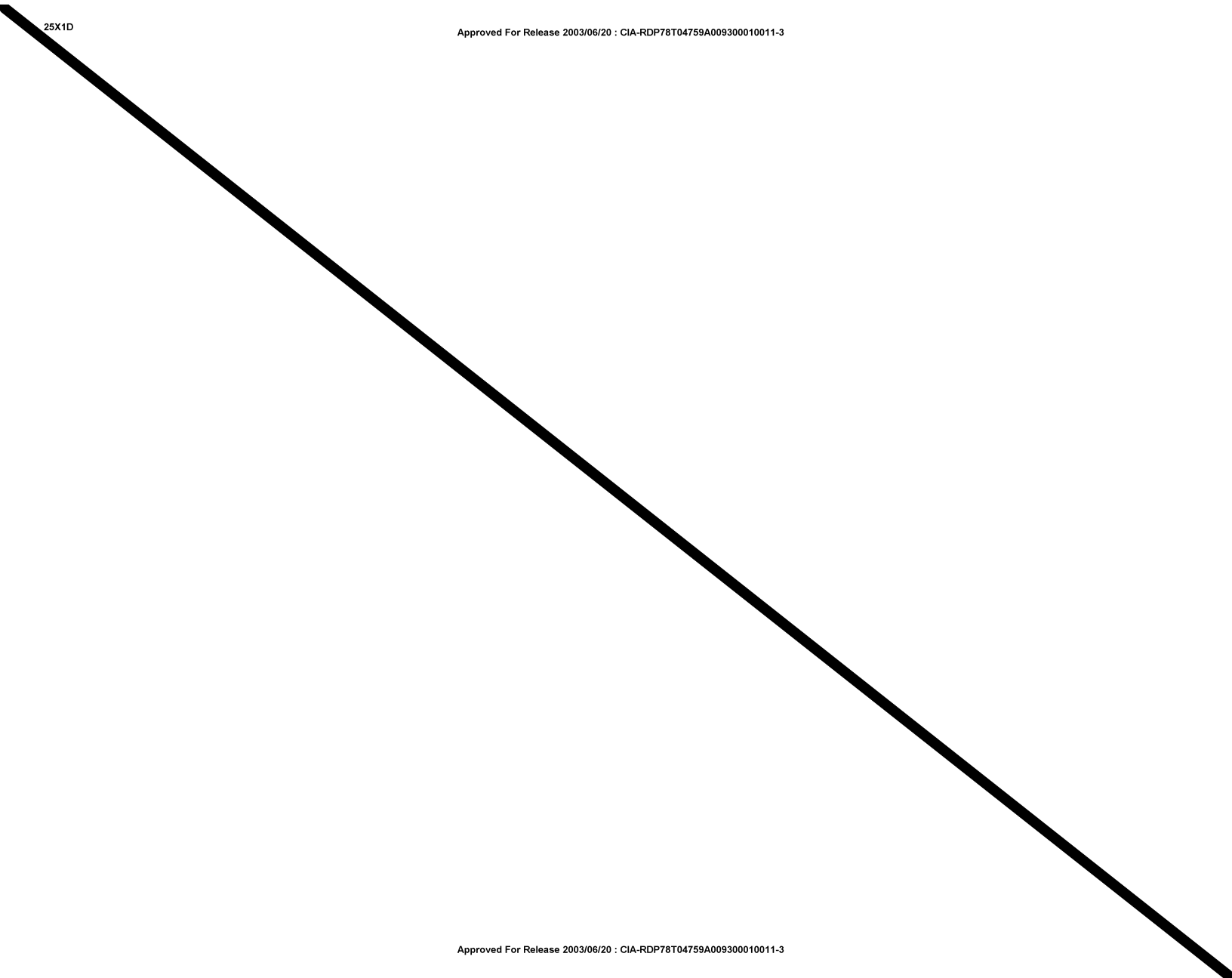


FIGURE 24. NOVOSIBIRSK HF COMMUNICATIONS FACILITY.



Approved For Release 2003/06/20 : CIA-RDP78T04759A009300010011-3

secured transmitting/control areas which have two cooling ponds each, two separately secured electrical power substations, and a general support area. The westernmost transmitting/control area serves only the probable LF antenna. The remaining control area serves all of the other antennas.

It is significant to note that this facility was operational at least nine years prior to the time the "typical" vertical radiator was constructed. This vertical radiator was constructed during the same period that vertical radiators were being constructed at the other much newer facilities. 25X1D

Chronology Razdolnoye was first observed in [redacted] At that time it was operational with two linear arrays completed, including two transmitting/control areas, a substation, and a general support area. It was first observed on 25X1D [redacted] photography on [redacted] There has been no discernible change since its first sighting.

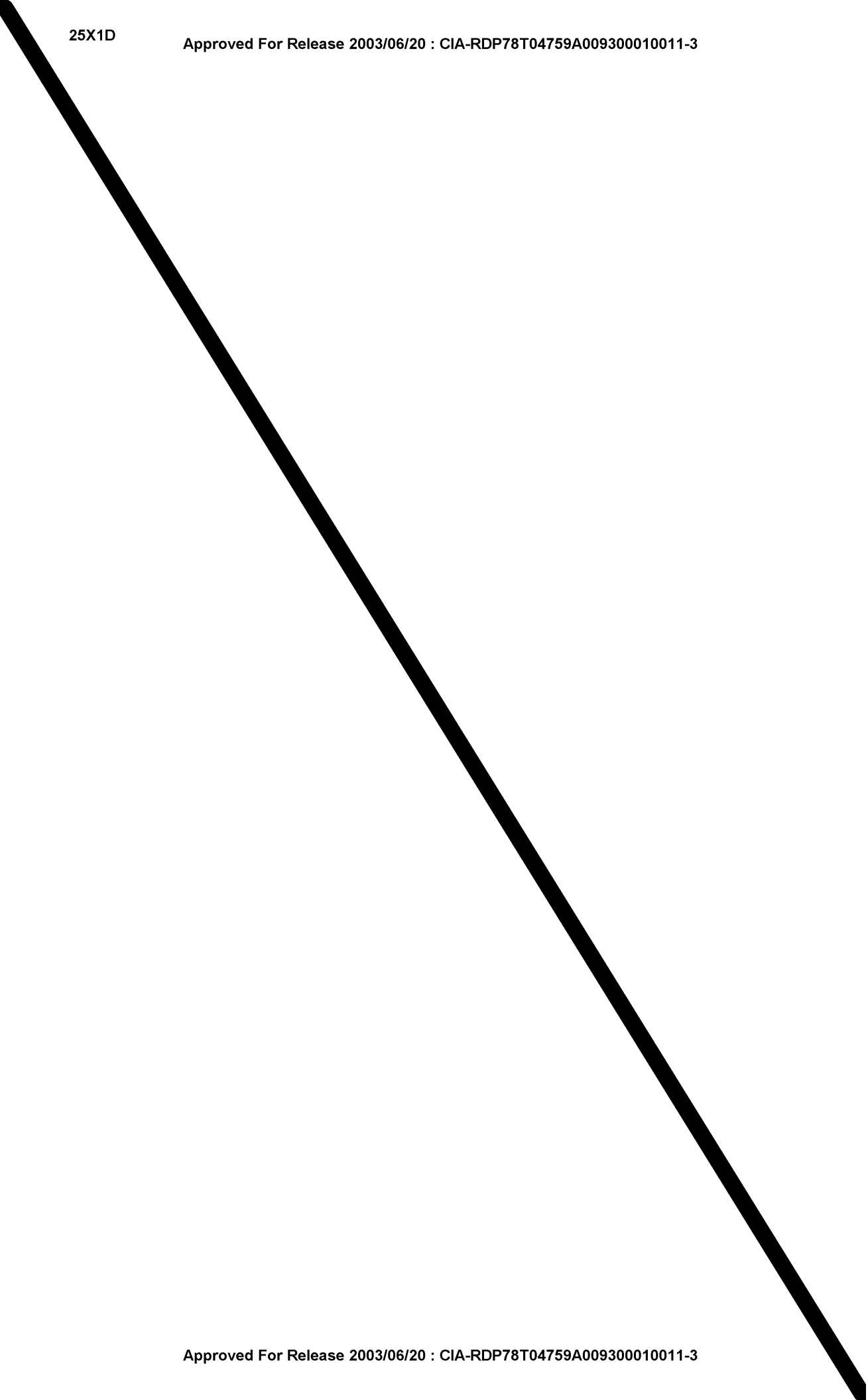
25X1D On [redacted] a hexagonal probable LF antenna was observed in the midstages of construction. A circular probable HF antenna, first observed on this mission, was located just north of the eastern transmitting building. No evidence of a MF vertical radiator could be detected. [redacted] a typical MF vertical radiator was observed in the early stage of construction, with guy-anchor foundations underway. 25X1D

25X1D [redacted] the best coverage to date, reveals the facility to be complete, except for the vertical radiator which is nearly complete. The latest coverage used to compile data on this facility is [redacted] 25X1D

25X1D

REFERENCES

[redacted]



REFERENCES (Continued)

[redacted]

MAPS OR CHARTS

ACIC. US Air Target Charts, Series 200, Scale 1:200,000

DOCUMENTS

[redacted] 25X1C

2. G.A. Savitskiy, Antenna Devices (Antennyye Ustroystva), (UNCLASSIFIED)

[13] Photographic missions subsequent to those listed show no significant changes.